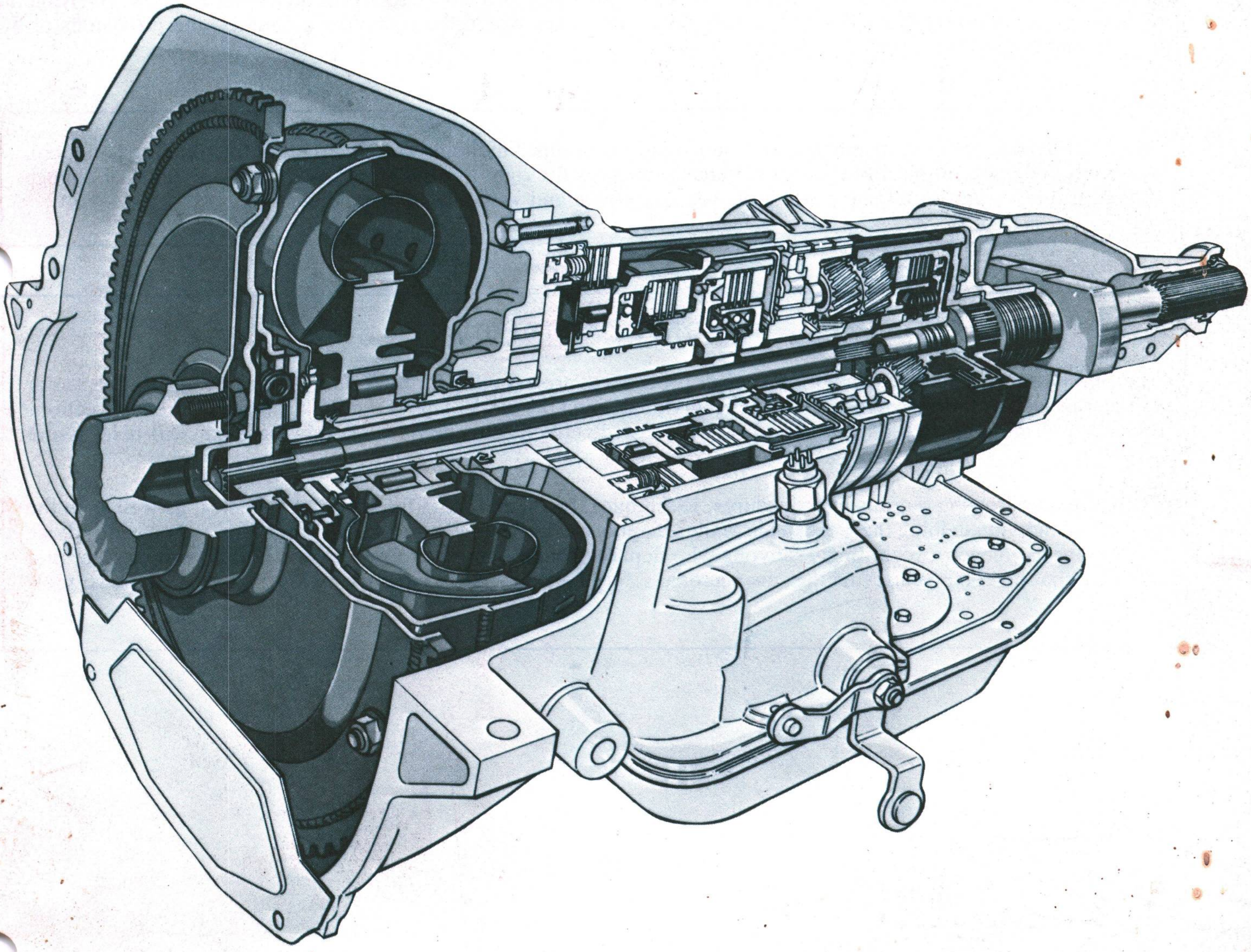
AUTOMATIC OVERDRIVE TRANSMISSION

OPERATION AND DIAGNOSIS



Ford Parts and Service Division
Training and Publications Department

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Appropriate service methods and proper repair procedures are essential for the safe, reliable operation of all motor vehicles as well as the personal safety of the individual doing the work. This Handbook provides general directions for accomplishing service and repair work with tested, effective techniques. Following them will help assure reliability.

There are numerous variations in procedures, techniques, tools, and parts for servicing vehicles, as well as in the skill of the individual doing the work. This Manual cannot possibly anticipate all such variations and provide advice or cautions as to each. Accordingly, anyone who departs from the instructions provided in this Manual must first establish that he compromises neither his personal safety nor the vehicle integrity by his choice of methods, tools or parts.

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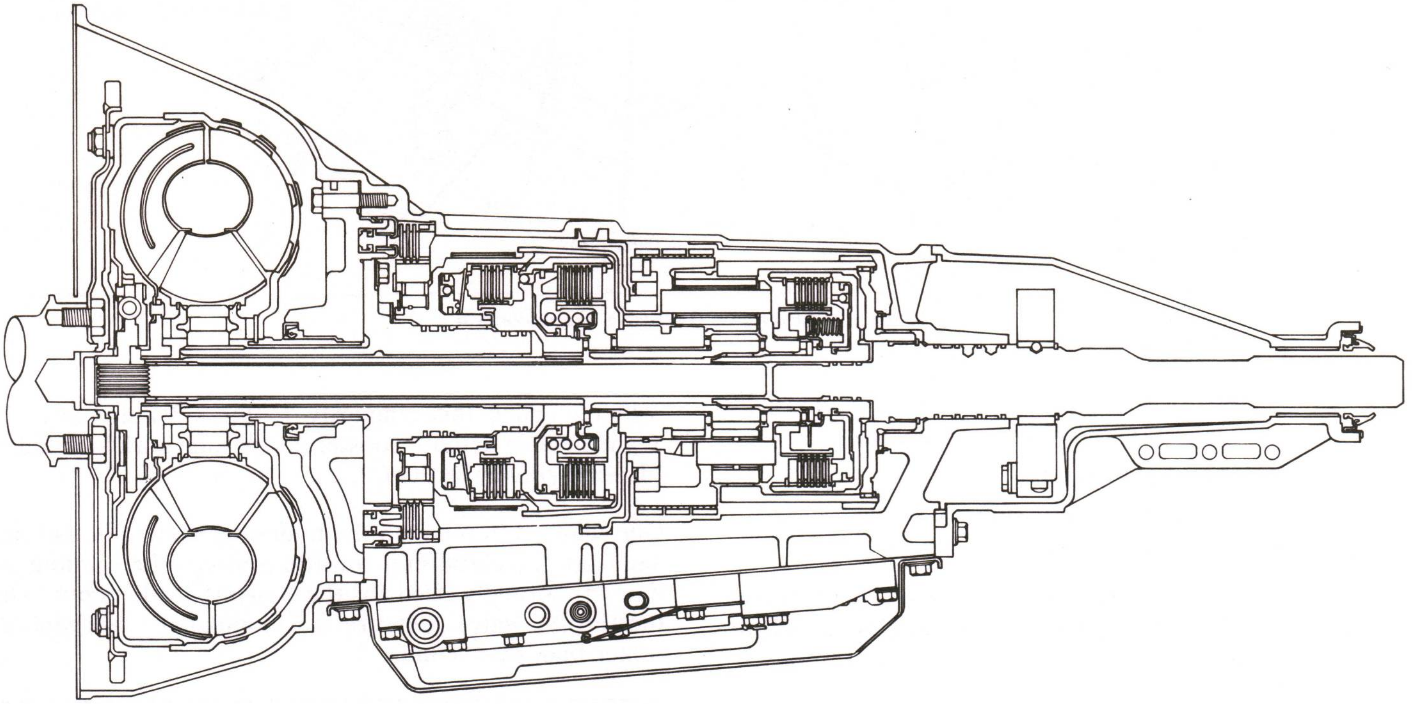
AUTOMATIC OVERDRIVE TRANSMISSION

SECTION 1

GENERAL DESCRIPTION



AUTOMATIC OVERDRIVE TRANSMISSION GENERAL DESCRIPTION

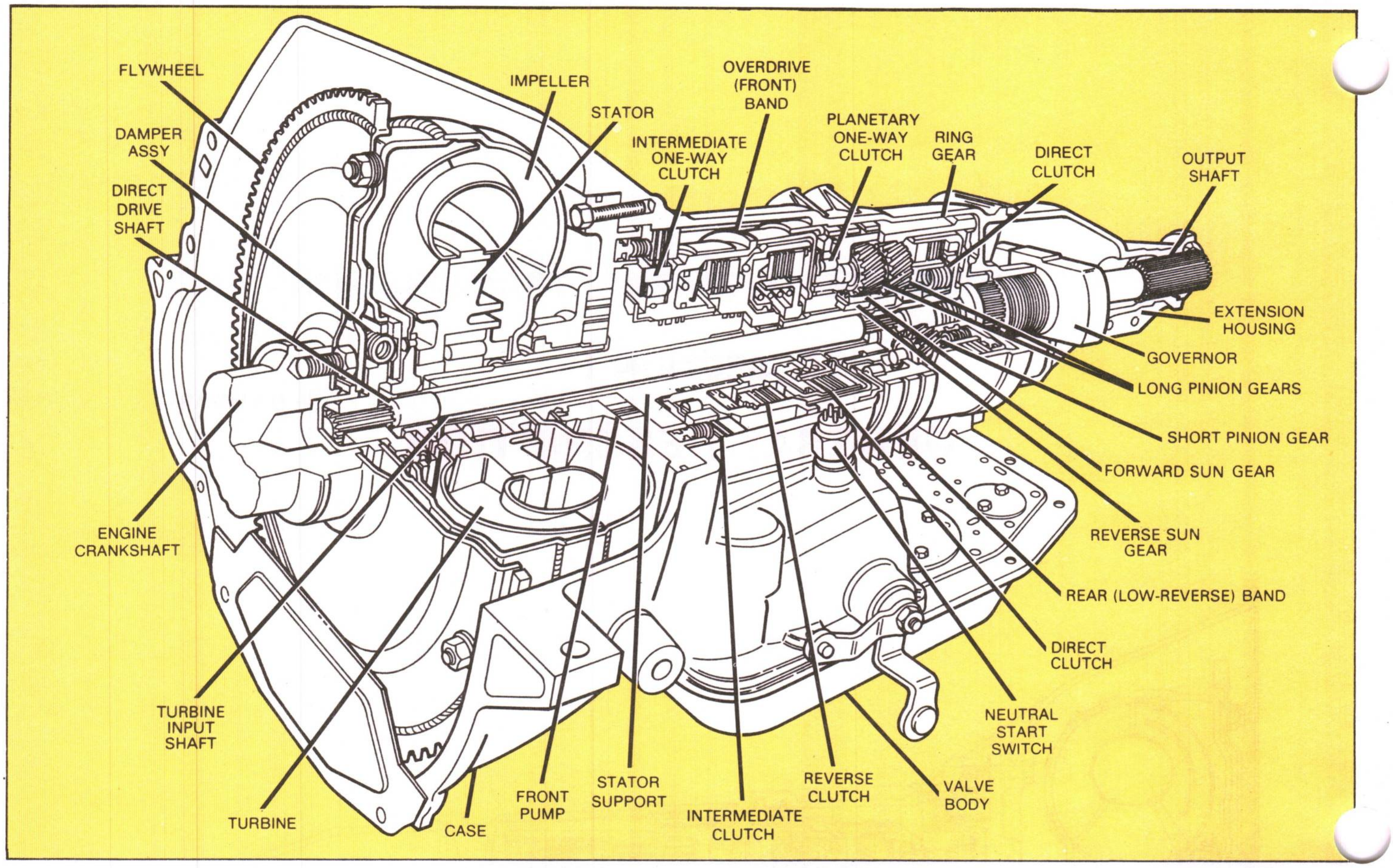


Figure 1 — Automatic Overdrive Transmission

Like other Ford automatics, the automatic overdrive transmission (Figure 1) consists essentially of:

1. A torque converter assembly
2. A compound planetary gear train
3. A hydraulic control system

The torque converter operation is similar to other automatics; but has an added damper assembly and input shaft for high and overdrive gears.

An FMX type gear train is used. First, second and high gears have basically the same power flow as in the FMX, except that in third gear, the input torque is split between two shafts. Overdrive is accomplished by the addition of a band to lock the reverse sun gear while driving the planet carrier. Engine torque flows through the damper assembly to by-pass the torque converter. For control of the gears, the automatic overdrive has four friction clutches, two roller (one-way) clutches and two bands. The overdrive servo and direct clutch are new, an intermediate clutch replaces the front band.

In the hydraulic system, the oil pump and stator support are similar to the C6. As shown in Figure 2, the band servo pockets and the valve body upper passages are cast into the case. Experienced automatic transmission technicians will recognize this similarity to the C3 automatic. The manual valve detent "rooster comb" and park lock linkage also are similar to the C3.

One major difference in the hydraulic system is that linkage from the carburetor throttle replaces the vacuum diaphragm normally used for the "engine load" input. Thus the throttle valve pressure is "modulated" mechanically rather than by vacuum.

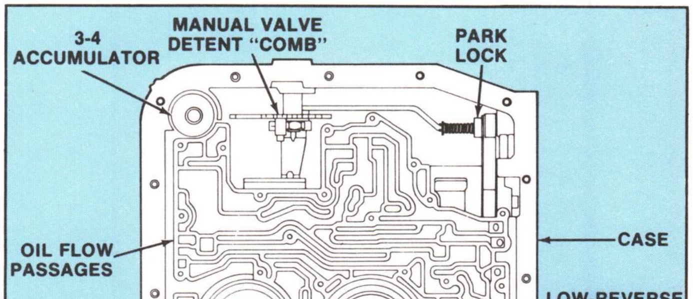


Figure 2 — View of Case Oil Passages and Park Linkage

MAIN COMPONENTS AND FUNCTIONS

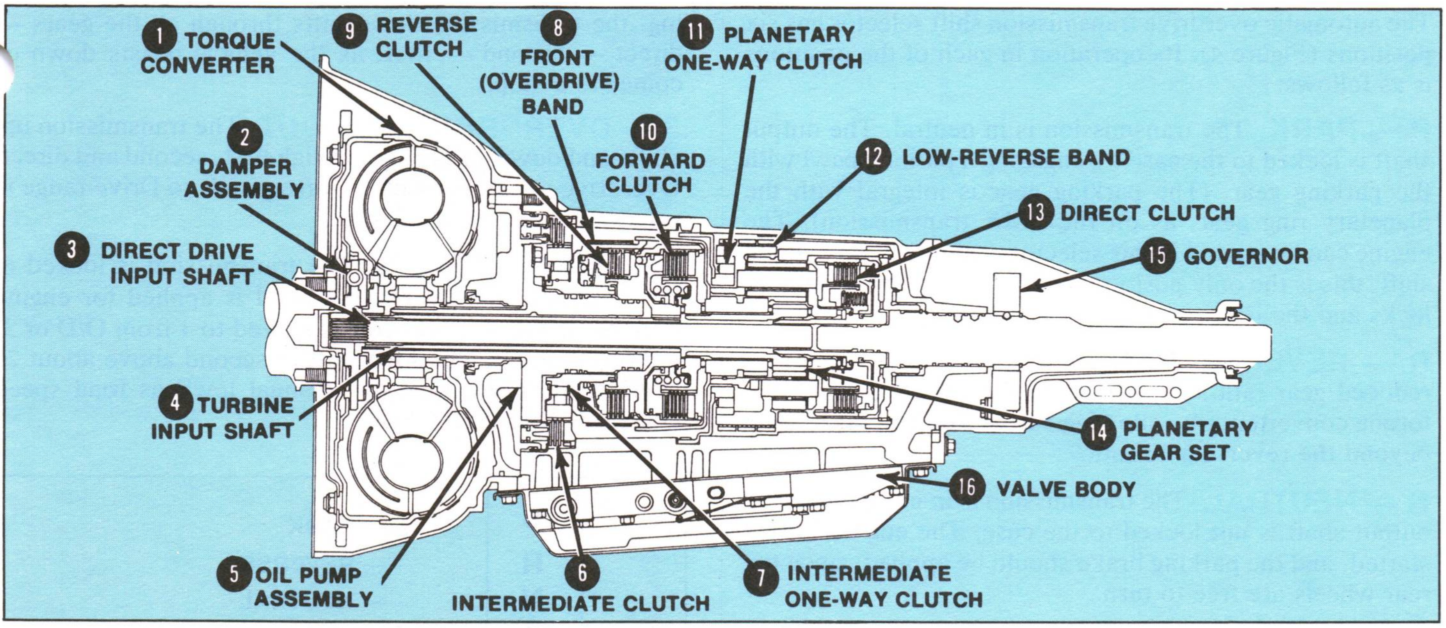


Figure 3 — Cross-Section View of Automatic Overdrive Transmission to Identify Main Components

In the following sections, the functions of the automatic overdrive components will be developed in detail. For general familiarization, please refer to the key numbers on Figure 3. Also, you can compare Figure 3 with Figure 1 to better visualize the parts and their assembled relationships.

① **TORQUE CONVERTER** — Couples the engine to the planetary gear train. Also provides torque multiplication, which is equivalent to additional gear reduction in some driving conditions.

② **DAMPER ASSEMBLY** — Cushions engine shock to the transmission when mechanical drive is being used (as opposed to hydraulic coupling through the converter).

③ **DIRECT DRIVE INPUT SHAFT** — Couples the engine directly to the direct clutch; by-passing the torque converter. It is driven by the torque converter cover through the damper assembly.

④ **TURBINE INPUT SHAFT** — Splined to the converter turbine to transmit torque from the converter to the reverse clutch or the forward clutch.

⑤ **OIL PUMP ASSEMBLY** — Provides a constant supply of oil under pressure to operate, lubricate and cool the transmission.

⑥ **INTERMEDIATE CLUTCH** — Holds the reverse sun gear stationary in second gear.

⑦ **INTERMEDIATE ONE-WAY CLUTCH** — Works with the intermediate friction clutch to hold the reverse sun gear stationary in second gear. (This clutch overruns or free-wheels in third gear.)

⑧ **FRONT (OVERDRIVE) BAND** — Holds the reverse sun gear stationary in overdrive and in second gear in range 1. Operated by a band servo (Figure 2).

⑨ **REVERSE CLUTCH** — Couples the **turbine** (tube) input shaft to the reverse sun gear in reverse only.

⑩ **FORWARD CLUTCH** — Couples the **turbine** (tube) input shaft to the forward sun gear in first, second and third gear.

⑪ **PLANETARY (LOW) ONE-WAY CLUTCH** — Holds the planet carrier stationary in first gear in O/D and 3 ranges; and permits "free-wheeling" on an automatic coasting downshift to first gear.

⑫ **LOW-REVERSE BAND** — Holds the planet carrier stationary in manual low and reverse. Permits engine braking in manual low.

⑬ **DIRECT CLUTCH** — Couples the direct drive input shaft to the planet carrier assembly in third (direct) gear and in overdrive.

⑭ **COMPOUND PLANETARY GEAR SET** — Provides four forward speeds (two reduction, direct and overdrive) plus reverse, depending on clutch and band application.

⑮ **GOVERNOR** — Sends a pressure "road speed" signal to the hydraulic system for upshift and downshift control.

⑯ **CONTROL VALVE BODY** — Directs fluid under pressure to the torque converter, band servos, clutches and governor to control transmission operation.

SHIFT SELECTOR POSITIONS

The automatic overdrive transmission shift selector has six positions (Figure 4). Its operation in each of the positions is as follows:

P — PARK. The transmission is in neutral. The output shaft is locked to the case by engaging a parking pawl with the parking gear. (The parking gear is integral with the planetary ring gear, as on the FMX transmission). The engine can be started in this selector position. With column shift, this is the only position in which the steering column locks and the ignition key can be removed.

R — REVERSE. The transmission is in reverse at a reduced gear ratio. Drive is from the engine through the torque converter only; allowing extra torque multiplication beyond the reverse gear ratio.

N — NEUTRAL. The transmission is in neutral, but the output shaft is **not** locked to the case. The engine can be started, and the parking brake should be applied, since the rear wheels are free to turn.

O/D — OVERDRIVE. This is the normal driving range. The transmission will upshift and downshift automatically through all the forward gears: first, second, third (direct) and overdrive. From a standing start, the transmission is in low gear and successively upshifts to second, direct and overdrive as road speed increases. Coasting down or braking, the transmission downshifts through all the gears — direct — second — first, as the vehicle coasts down c comes to a stop.

3 — OVERDRIVE LOCKOUT. The transmission upshifts and downshifts only through first, second and direct. Overdrive is "locked-out". Corresponds to Drive range in other automatic transmissions.

1 — MANUAL LOW. The transmission is locked in low gear and the low-reverse band is applied for engine braking. If the shift selector is moved to 1 from O/D or 3, the transmission will downshift to second above about 25 MPH road speed, then to "manual low" as road speed decreases below 25 MPH.

P — **PARK**
R — **REVERSE**
N — **NEUTRAL**
Ⓓ — **OVERDRIVE**
3 — **OVERDRIVE LOCKOUT**
1 — **MANUAL LOW**

Figure 4 — Automatic Overdrive Shift Selector Positions

FORCED DOWNSHIFTS

Forced downshifts (as opposed to coasting downshifts) are possible at cruising speeds in both the O/D and the 3 range. It is not necessary to move the shift selector to "force" a downshift; only to press on the accelerator pedal.

TORQUE DEMAND DOWNSHIFT

A "torque demand" downshift occurs because the torque needed is more than the engine can generate. It can happen in one of two ways; or a combination of these.

1. The operator opens the throttle wider. The throttle linkage causes an "increased load" signal to go to the valve body and the transmission downshifts. A "passing gear" kickdown shift can occur the same way as the driver calls for increased acceleration for passing.

2. Road speed drops off so that the governor sends a decreased pressure signal to the valve body and a downshift occurs.

Torque demand downshifts occur at less than wide-open throttle with only road speed or engine load (throttle opening) changes. At wide-open throttle, for maximum acceleration, "through-detent" (kickdown) downshifts can be forced to lower gears at higher road speeds.

THROUGH-DETENT (KICKDOWN) DOWNSHIFTS

A through-detent downshift occurs when the accelerator is pressed to the floor to actuate the throttle valve to full line pressure **and** open a kickdown passage from the throttle plunger to the shift valves. This will be explained in the Hydraulic System section.

IT DEPENDS ON THE RANGE

From O/D range fourth gear, downshifts can be forced to direct (third) or second gear depending on road speed and throttle opening. In 3 range, downshifts can be forced to either second or low gear.

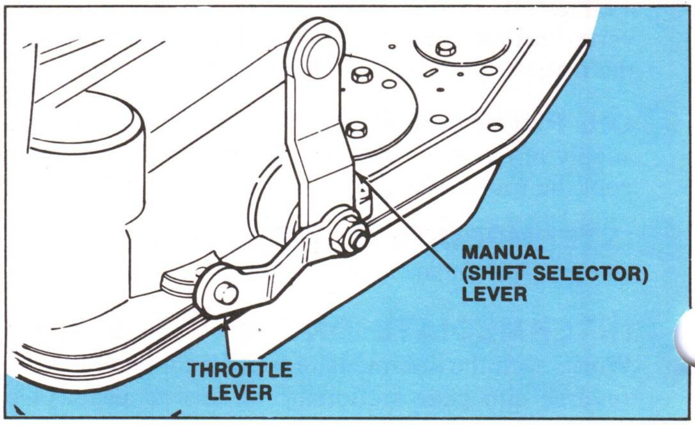
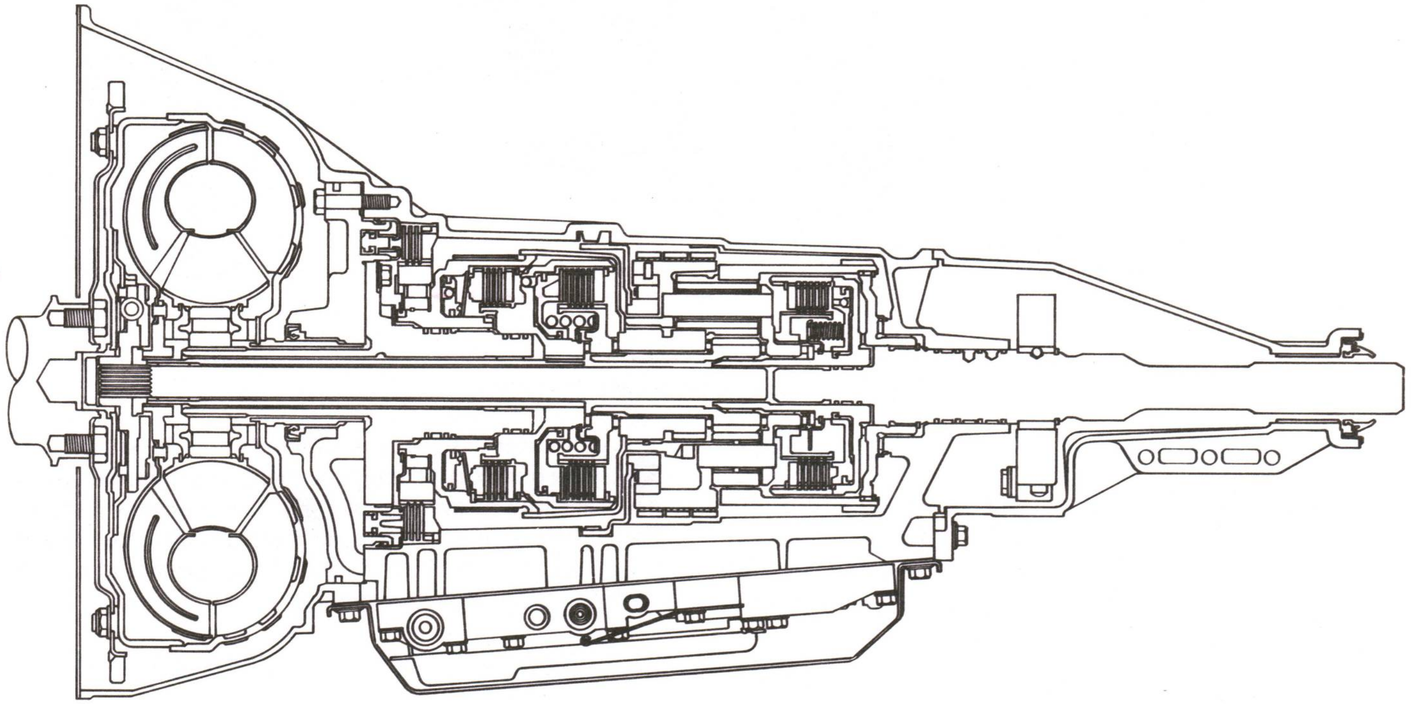


Figure 5 — Throttle Lever and Manual Lever

AUTOMATIC OVERDRIVE TRANSMISSION

SECTION 2

TORQUE CONVERTER



CONVERTER POWER FLOW

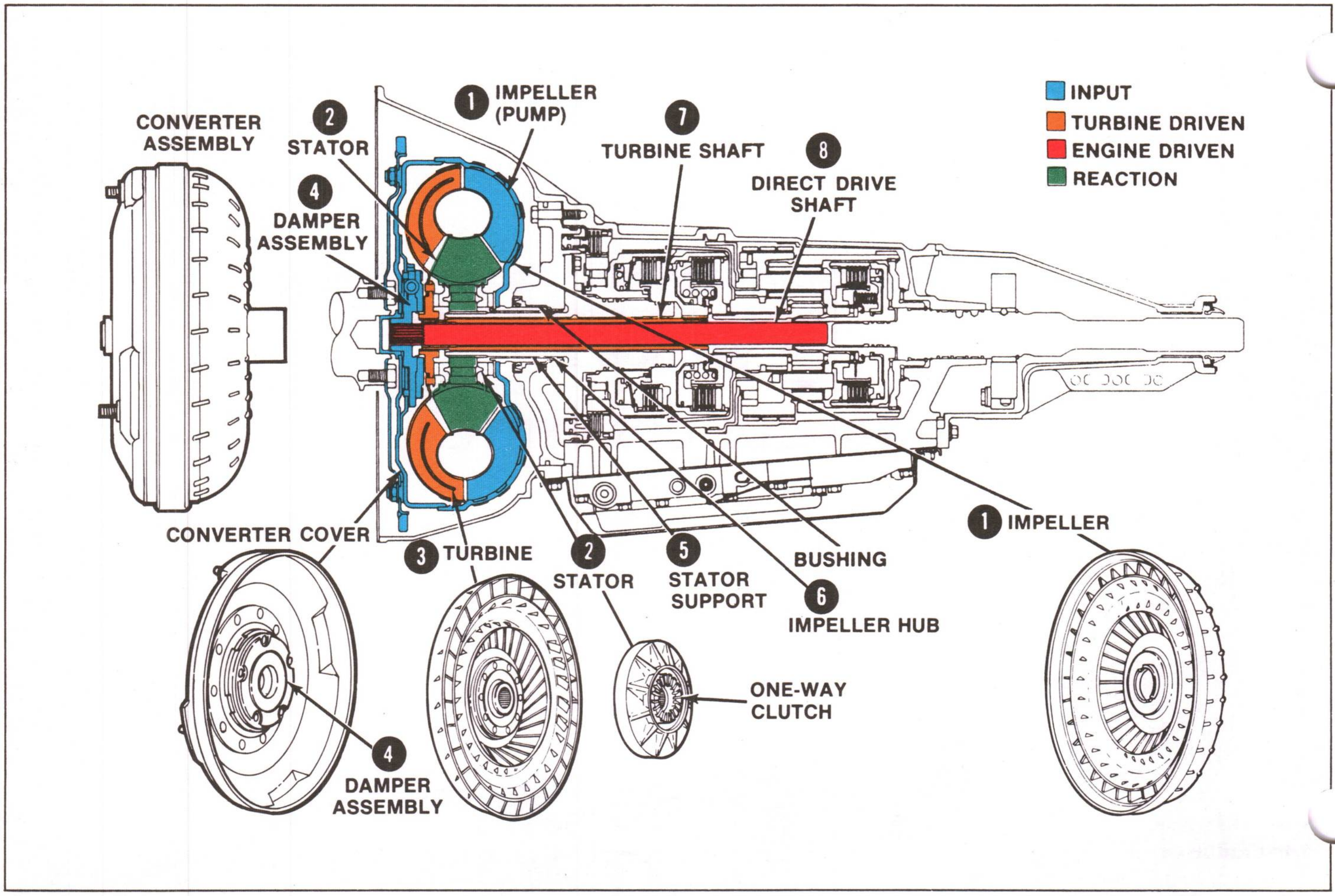


Figure 6 — Torque Converter and Power Flow

TORQUE CONVERTER COMPONENTS

The automatic overdrive torque converter (Figure 6) differs from other Ford automatics only in having **two** power inputs to the gear train. As a fluid coupling and "torque multiplier," it is essentially the same as the C6 converter. Its principal parts are:

❶ **IMPELLER** — Also called the converter "pump," the impeller is driven through the welded converter cover by the engine flex plate. Thus it is the "input" member of the converter assembly. It also forms the rear housing of the welded assembly.

❷ **STATOR** — This is the stationary or "reaction" member for torque multiplication. It controls oil flow from the impeller in the "reduction" phase of converter operation.

❸ **TURBINE** — Driven by oil set in motion by the impeller. The turbine is the output member of a torque converter.

❹ **DAMPER ASSEMBLY** — Smooths or cushions engine shock for mechanical or "hard" drive; that is, where the converter is by-passed.

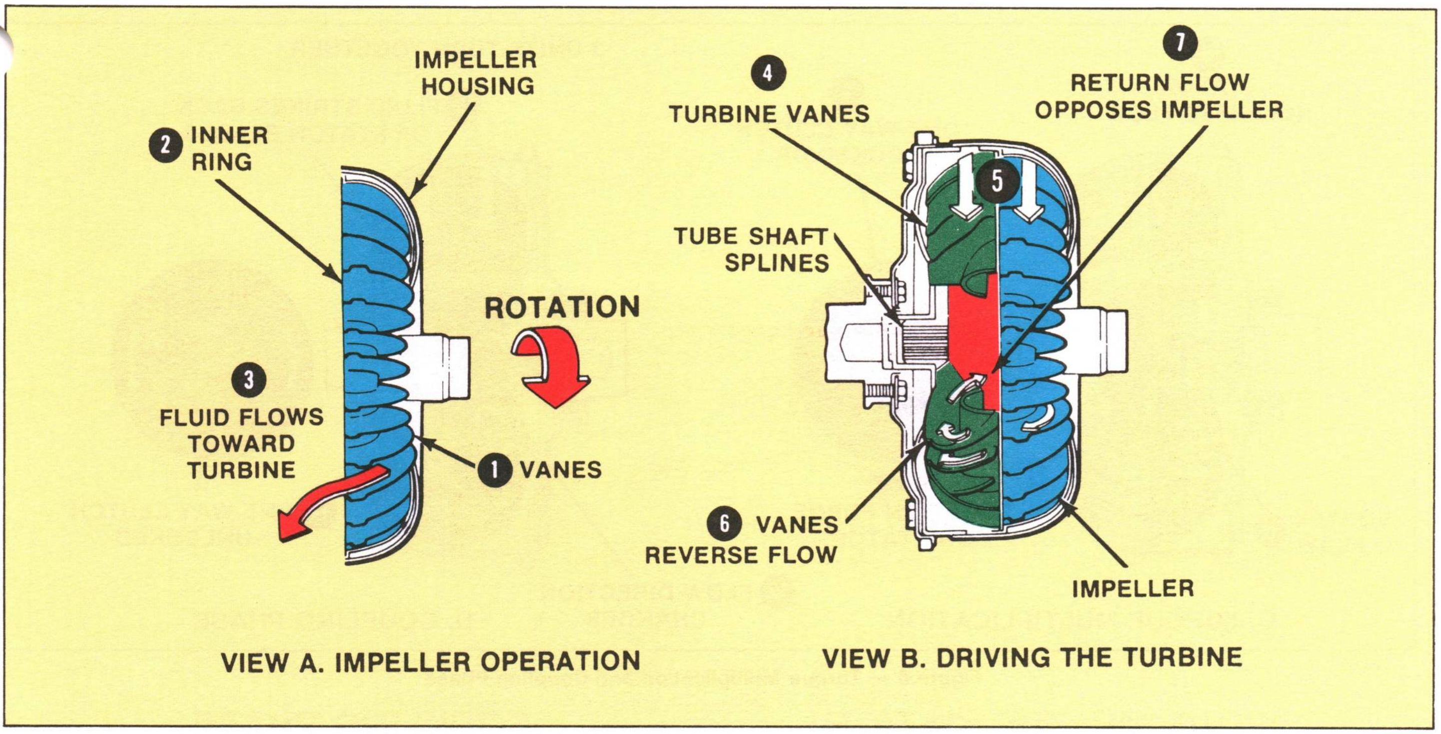
The converter assembly is supported on the stator support ❺, which is part of the transmission oil pump assembly. The rear hub of the impeller ❻ is supported by the pump body bushing and is used to drive the pump gears. Thus the oil pump delivers fluid to the transmission and converter whenever the engine is running.

POWER TO THE GEAR TRAIN

Input to the transmission gear train is through either the turbine input shaft ❼ or the direct drive input shaft ❽, or a combination of both.

- In reverse, first and second gears, the turbine input shaft transmits torque from the turbine to the reverse clutch or forward clutch. This is a hydraulic drive, since the impeller must drive the turbine with hydraulic oil.
- In fourth gear (overdrive), the direct drive input shaft transmits torque to the rear (direct) clutch. This is a solid (mechanical) drive, since the turbine is by-passed. The damper assembly drives the shaft at engine spee
- In third gear torque is split between the two shafts. The drive torque is about 40 percent hydraulic and 60 percent mechanical.

HOW THE CONVERTER WORKS



VIEW A. IMPELLER OPERATION

VIEW B. DRIVING THE TURBINE

Figure 7 — Impeller and Turbine Drive

AN AUTOMATIC HYDRAULIC CLUTCH

Now, let's describe the operation of the torque converter in **hydraulic** or "soft" drive conditions. Primarily we are talking reverse, low and second gears.

In hydraulic drive, the converter functions as (1) an automatic clutch and (2) a torque multiplier when engine load requires more torque. Remember that:

1. The engine drives the impeller mechanically.
2. The turbine is driven hydraulically by the impeller.
3. The turbine drives the tube input shaft for input to the gear train.

IMPELLER PUMPS FLUID

The purpose of the impeller is the same as any pump — to put the fluid in motion. Inside the impeller housing (Figure 7, View A), many curved vanes, along with an inner ring, form passages for the fluid to flow through. The rotating impeller acts as a centrifugal pump. Fluid is supplied by the hydraulic control system and flows into the passages between the vanes ①. When the impeller turns, the vanes accelerate the fluid and centrifugal force pushes the fluid outward so that it is discharged from openings around the inner ring ②. The curvature of the impeller vanes directs the fluid toward the turbine, and in the same direction as impeller rotation ③.

ROTARY FORCE ON TURBINE

As shown in View B of Figure 7, the vanes ④ in the turbine are curved opposite to the impeller. The impact of the moving fluid on the turbine vanes ⑤ exerts a force that tends to turn the turbine in the same direction as impeller rotation. When this force creates a great enough torque on the transmission tube (turbine output) shaft to overcome the resistance to motion, the turbine begins to rotate.

Now the impeller and turbine are acting as a simple fluid coupling, but we have no torque multiplication yet. To get torque multiplication, we must return the fluid from the turbine to the impeller and accelerate the fluid again to increase its force on the turbine.

VANES REVERSE THE FLOW

To get maximum force on the turbine vanes when the moving fluid strikes them, the vanes are curved to reverse the direction of flow ⑥. Less force would be obtained if the turbine deflected the fluid instead of reversing it. At any stall condition, that is, with the transmission in gear and the engine operating, but the turbine standing still, the fluid is reversed, by the turbine vanes and pointed back to the impeller. You can see, that without the stator, any momentum left in the fluid after it leaves the turbine ⑦ would resist the rotation of the impeller.

At this point, we have a simple fluid coupling that will cause the turbine to drive the input shaft with no torque multiplication. To gain multiplication (or hydraulic "reduction"), we must add the **reaction** member or stator (see Figure 8).

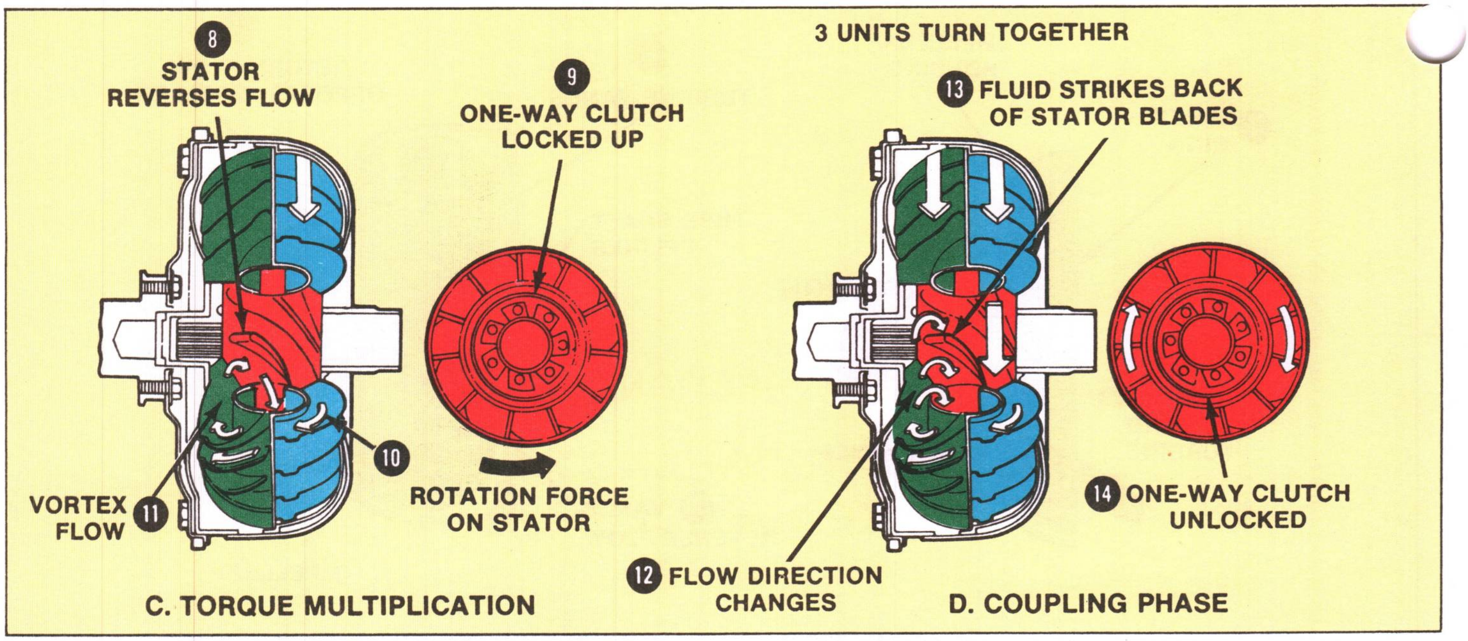


Figure 8 — Torque Multiplication and Coupling Phase

TORQUE MULTIPLICATION

When torque multiplication is required, the stator ⑧ in Figure 8, View C, reverses the fluid again and returns it to the impeller in the direction of impeller rotation. A one-way clutch ⑨ prevents the force of this fluid from turning the stator opposite the impeller and turbine.

As the fluid flows from the stator to the impeller, the impeller has another opportunity to accelerate the same fluid and it does so. The fluid ⑩ leaves the impeller with perhaps twice the energy it had the first time, and exerts a greater force on the turbine.

We call the flow of fluid ⑪ through the impeller, to the turbine, to the stator, and back through the impeller, the vortex flow. At high impeller speed and low turbine speed, the vortex flow velocity is the sum of the impeller produced velocity, plus the velocity of the fluid returning from the turbine and stator. It is vortex flow that gives us torque multiplication.

By torque multiplication, we mean that there is more torque on the turbine shaft than the engine is putting out — because the vortex fluid is accelerated more than once. Torque multiplication is obtained at the sacrifice of turbine rotation. Actually, it's no different from the mechanical advantage which you get from gearing down. You gain torque by sacrificing motion.

Torque multiplication takes place anytime the turbine is turning at less than 9/10 impeller speed. At full stall, the automatic overdrive converter produces about a 2.1-to-1 torque multiplication. As the turbine speed increases in relation to the impeller, torque multiplication decreases.

COUPLING PHASE

When the coupling phase (Figure 8, View D) is reached — that is, when the turbine speed is about 9/10 impeller speed — there is no longer any torque multiplication. The converter then is simply transmitting engine torque to the ge train.

As the turbine begins to rotate and steadily picks up speed, the vortex flow steadily loses speed because of the increasing centrifugal force acting against the flow through the turbine. The rotating impeller produced a centrifugal force in the fluid which caused it to flow from the center outward. The same centrifugal force is acting in the rotating turbine, trying to prevent the fluid from flowing inward. As the vortex flow slows down, torque multiplication is reduced.

As the turbine catches up with the impeller, the angle at which the fluid leaves the turbine is constantly changing ⑫. In the coupling phase, the fluid leaving the turbine strikes the backs of the stator vanes ⑬. The one-way clutch unlocks then ⑭ and the impeller, turbine and stator turn together.

CONVERTER AUTOMATICALLY ADJUSTS TORQUE

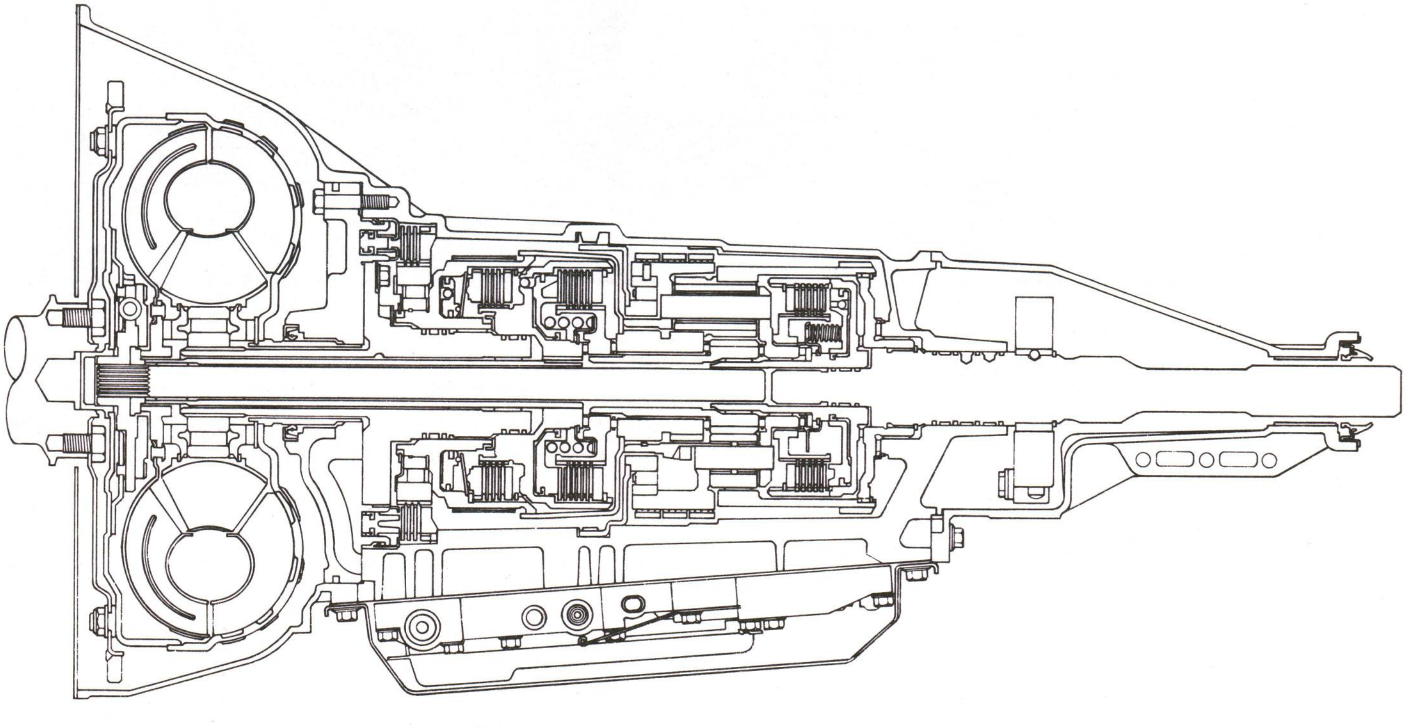
Since vortex flow speed is governed by the difference between impeller and turbine speed, the torque converter automatically adjusts converter output to drive sh torque requirements.

When the drive shaft torque requirements become greater than the engine output torque, the turbine slows down and causes an increase in vortex flow velocity; and thereby, an increase in torque multiplication.

AUTOMATIC OVERDRIVE TRANSMISSION

SECTION 3

PLANETARY GEARS AND GEAR TRAIN BUILD-UP



PLANETARY GEAR SYSTEM

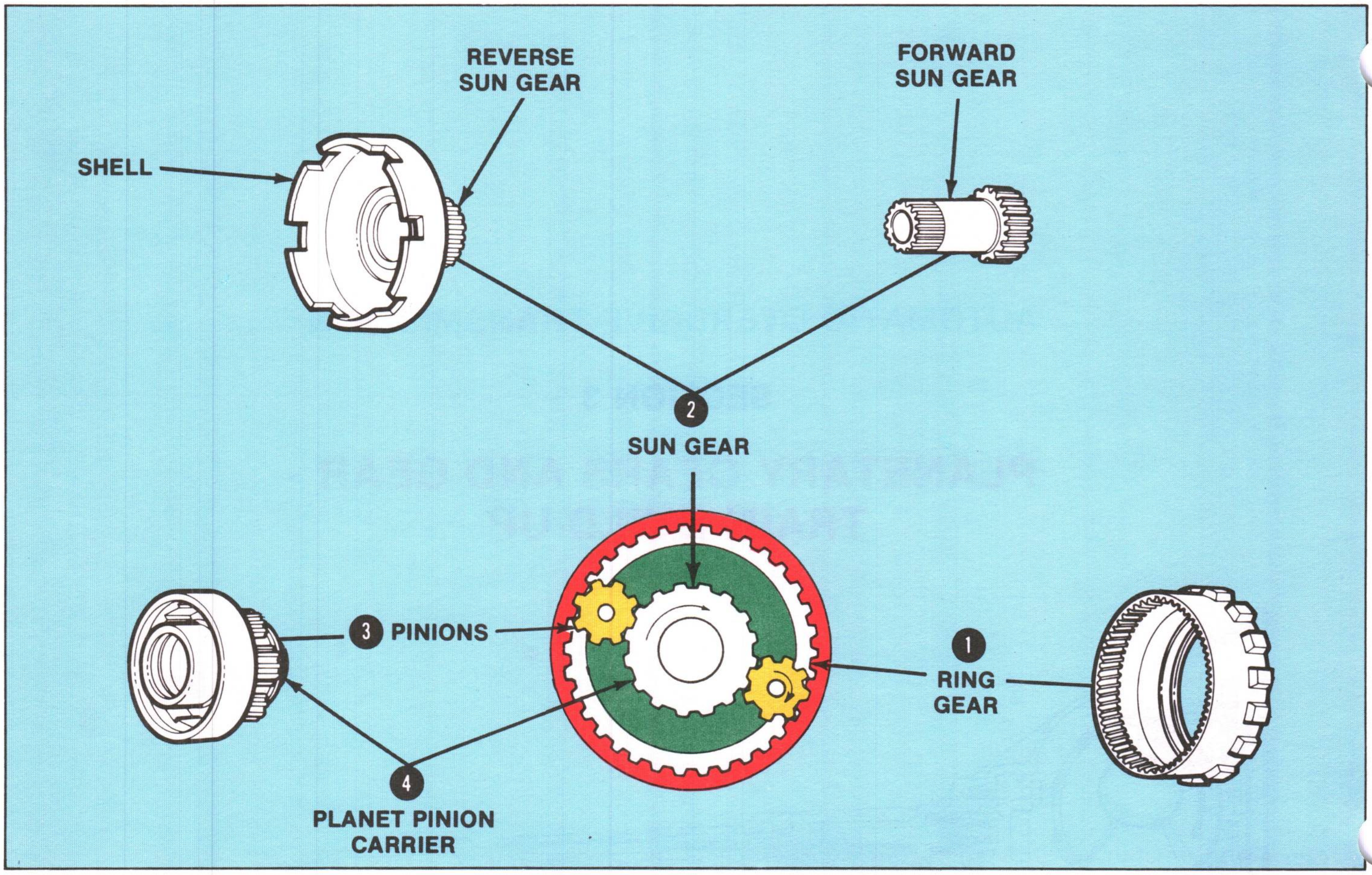


Figure 9 — Planetary Gearset

The automatic overdrive transmission uses a compound planetary gear system to achieve four forward speeds plus reverse. Two bands, four friction clutches and two one-way (overrunning) clutches are used to control the gear train operation. Before we see exactly how it is put together and operates, let's review the operating principles of a simple planetary gearset. Then we'll describe the compound gearset and how it is built up in the transmission.

THE SUN AND THE PLANETS

A simple planetary gearset (Figure 9) consists of an internal gear or **ring gear** ❶ , a **sun gear** ❷, and a number of **planet pinions** ❸ . The planet pinions are mounted on shafts or pins on a **planet pinion carrier** ❹ . Thus, the pinions can rotate on their own axes, and also can revolve about the sun gear if the pinion carrier is free to turn. The gearset and its parts get their name from their parallel with the sun and the planets.

ALWAYS IN MESH

One thing that's immediately evident about this gearset is that the gears are always in mesh. You can also see that unlike the spur gears in a manual-shift transmission, planetary gears are not subject to high side loads when they're under torque. Also, we have many more teeth working at any time in a planetary gearset. What this all adds up to is that the driver doesn't have to be nervous about doing a lot of driving in the lower gears — such as in stop and start traffic or using first gear for down-hill braking. Planetary gearsets have high torque-carrying capacity and gear failures occur very infrequently.

GEAR COMBINATIONS

With a single planetary gearset, we have a number of possible gear combinations. These are:

1. NEUTRAL
2. REDUCTION
3. DIRECT DRIVE
4. OVERDRIVE
5. REVERSE

Let's describe briefly how each can be accomplished; since all are used in the automatic overdrive transmission.

1. NEUTRAL

Neutral can occur in various ways. Any one of the planetary members can be driven (by the input shaft) and there will be no output so long as neither of th other members is held. In practice, neutral happens because there is **no** input. In other words, the clutches that couple the input shafts to the gear train are disengaged and none of the members are driven.

PLANETARY GEARSET COMBINATIONS

2. REDUCTION

A simple reduction operation in a planetary gearset is shown in Figure 10.

❶ The sun gear is held stationary.

❷ The ring gear is driven.

❸ The planet carrier is the output.

Rotation of the ring gear causes the planet pinions ❹ to "walk" around the sun gear in the same direction the ring gear is turning; but not as fast. Input torque is increased or multiplied, since output speed is less than input.

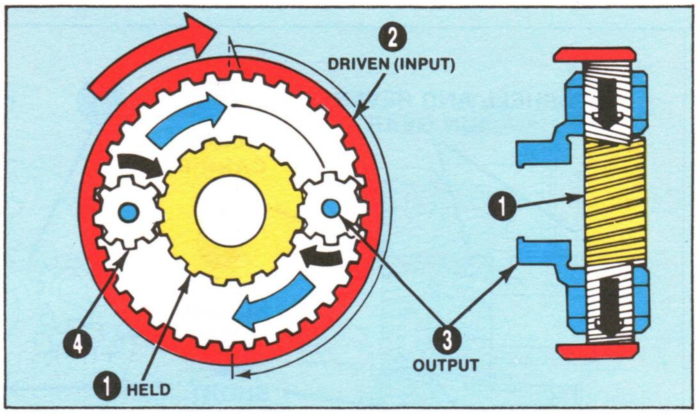


Figure 10 — Simple Reduction Example

3. DIRECT DRIVE

Direct drive is accomplished in the planetary gearset by:

- Locking any two members together, or
- Driving any two members from the same input.

The entire planetary gearset always rotates as a unit when any two members are locked together.

For instance, in Figure 11, the planet carrier ❶ and the sun gear ❷ are locked together and driven by the input shaft. The gearset locks up and the output to the ring gear ❸ is direct drive.

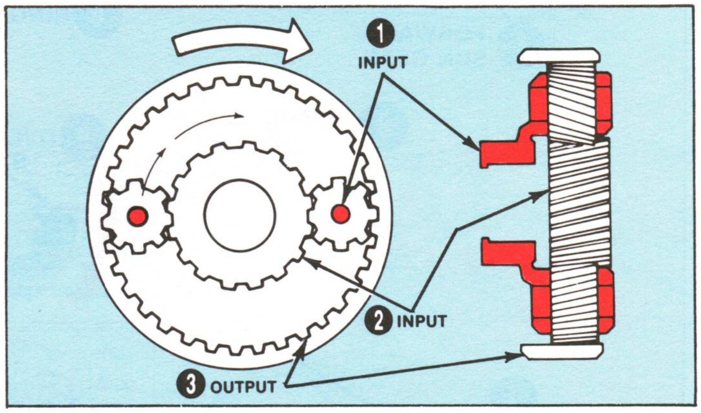


Figure 11 — Direct Drive Example

4. OVERDRIVE

Overdrive (Figure 12) is possible by:

❶ Holding the sun gear, and

❷ Driving the pinion carrier.

The pinion gears are forced to walk around the stationary sun gear and drive the ring gear ❸ at a faster speed than input.

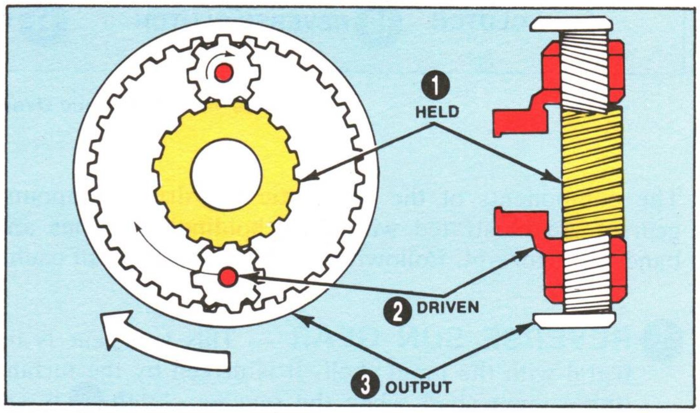


Figure 12 — Overdrive

5. REVERSE

A simple reverse is shown in Figure 13.

❶ The pinion carrier is held stationary.

❷ The sun gear is driven.

❸ The ring gear is the output.

In this example, the input drive is clockwise, the planet pinions are forced to turn counterclockwise, and pinion rotation causes the ring gear to be driven counterclockwise as well.

It's important to note here that the above are representative examples, illustrating a **simple** gearset operation. The design of the automatic overdrive **compound** gearset is such that some drives are accomplished differently. We will describe them in detail as we cover each of the gears.

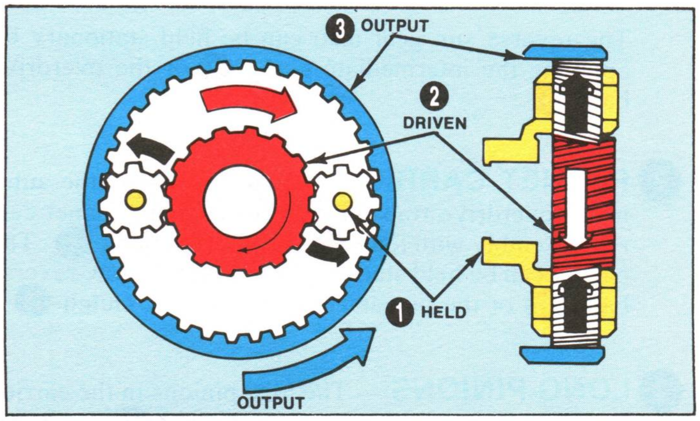


Figure 13 — Reverse Example

AUTOMATIC OVERDRIVE GEARSET AND HOLDING MEMBERS

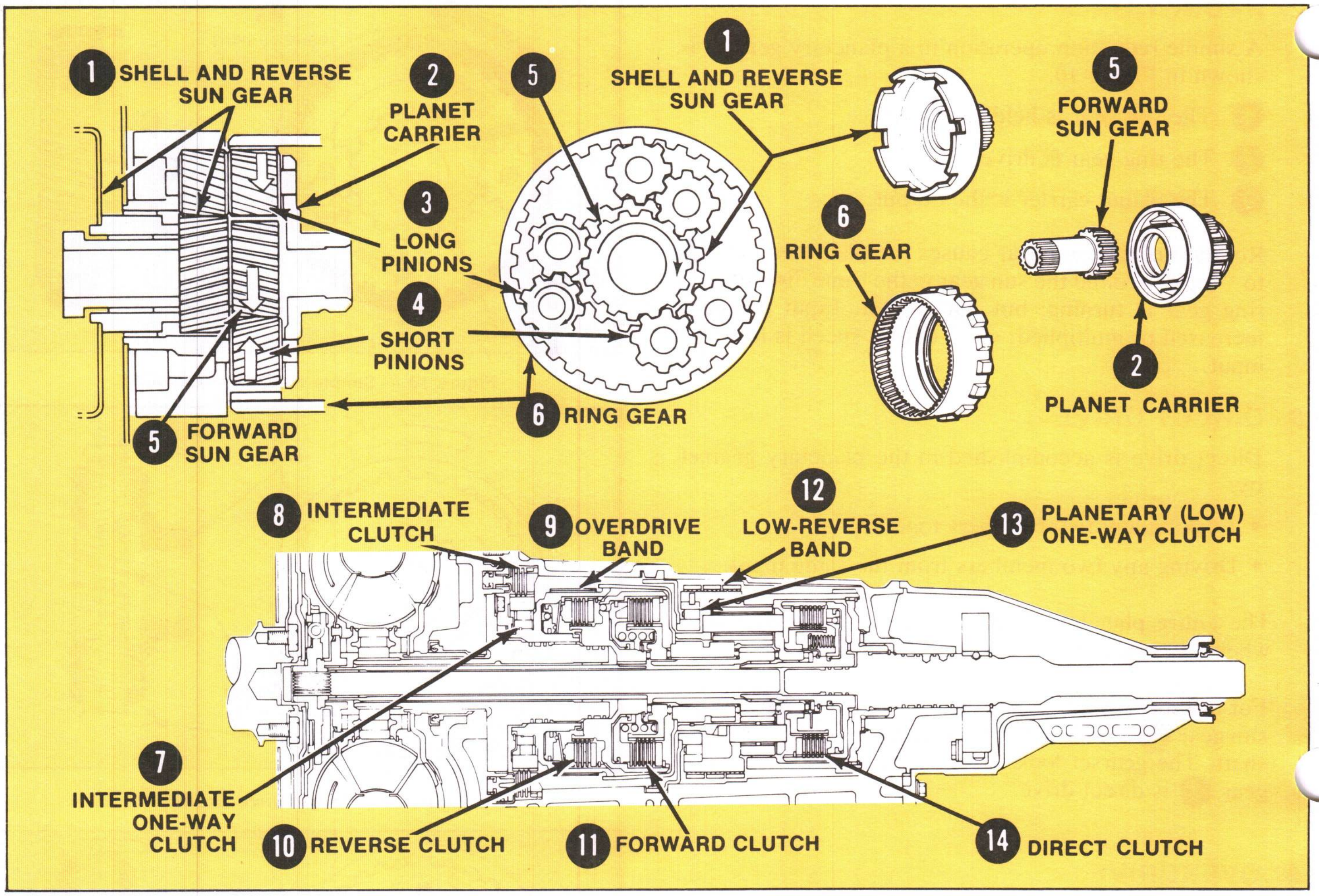


Figure 14 — Automatic Overdrive Compound Planetary Gearset

The components of the automatic overdrive compound gearset are illustrated with the "holding" clutches and bands in Figure 14. Following is a brief summary of each.

① **REVERSE SUN GEAR** — This sun gear is integral with the input shell. It is driven by the turbine (tube) input shaft when the reverse clutch ⑩ is applied. (It turns freely from the forward sun gear ⑤.)

The reverse sun gear also can be held stationary by applying the intermediate clutch ⑧ or the overdrive band ⑨

② **PLANET CARRIER** — Like the FMX, the automatic overdrive transmission has a single planet carrier assembly with long ③ and short pinions ④. The carrier can be held stationary by either the low-reverse band ⑫ or the planetary (low) one-way clutch ⑬ .

③ **LONG PINIONS** — The long pinions in the carrier are in constant mesh with the ring gear ⑥ , with the **reverse** sun gear ① and with the short pinions ④ .

④ **SHORT PINIONS** — Short pinions are in constant mesh with the **forward** sun gear ⑤ and with the long pinions ③ . The short pinions in this gearset do not mesh with a ring gear; but can only drive the ring gear through the long pinions.

⑤ **FORWARD SUN GEAR** — The forward sun gear is so named because it is driven whenever the forward clutch ⑪ is applied; that is, in first, second and third gears. (Physically it is located behind the reverse sun gear and corresponds to the "primary" sun gear in the FMX.) This sun gear meshes with the **short** planet pinions ④ .

⑥ **RING GEAR** — The automatic overdrive has only one ring gear, which meshes with the **long** planet pinions. It is splined to a flange on the output shaft. Thus the output from this gearset is always through the ri gear.

With that background, we can now begin to "build-up" the gear train and show the power flow in the various driving combinations.

INPUT AND OUTPUT SHAFTS

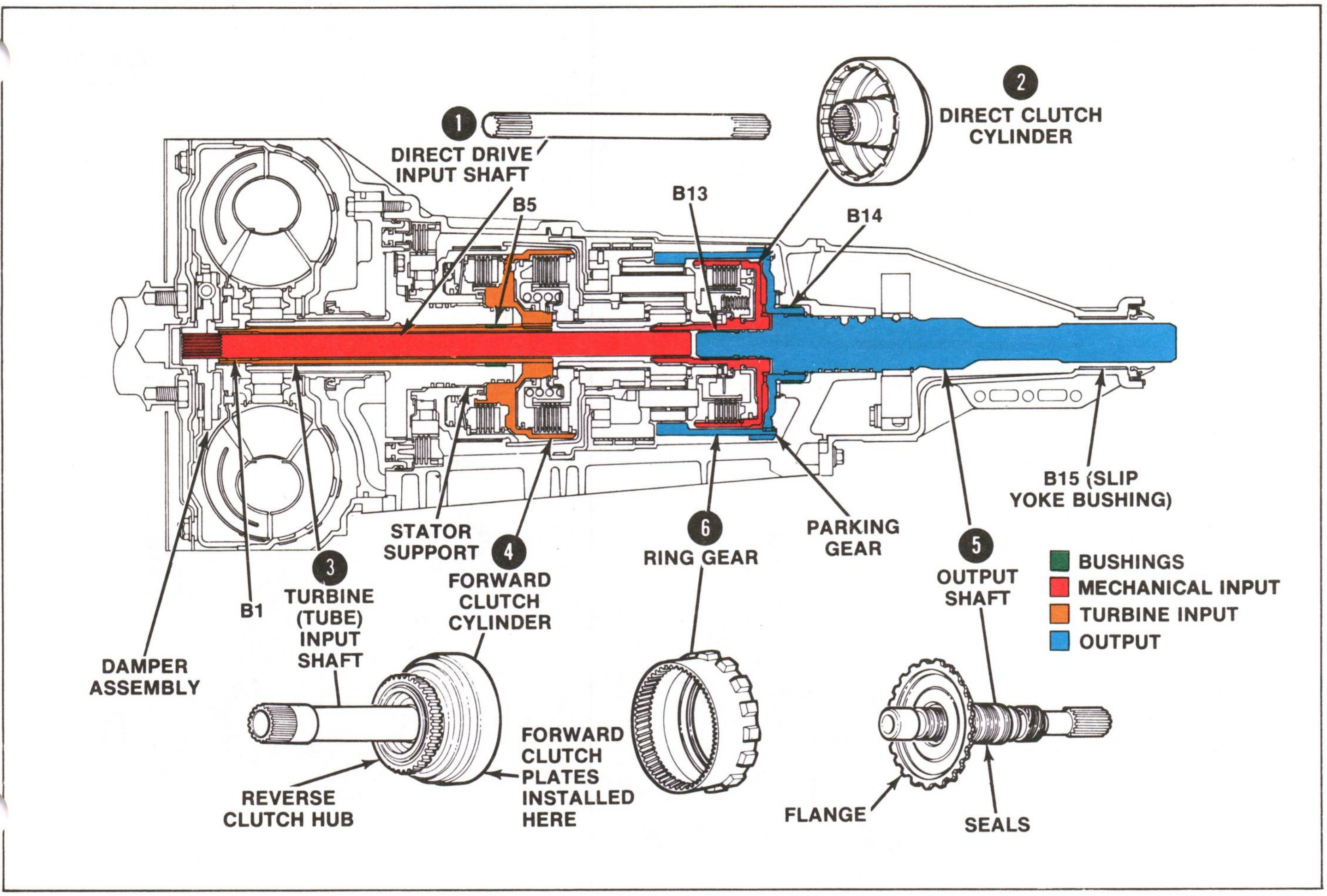


Figure 15 — Input and Output Shafts and Supports

POWER FLOW BUILD-UP

Let's build-up the gear train piece by piece. In the build-up, each piece can be examined as to its own construction and as to its possible connection and disconnection with other pieces. This procedure also makes it possible to observe the piece in its natural state, and then to observe it in its cut-in-two state in the sectioned view.

The order we'll follow is for demonstration purposes only; to show how power flows in the transmission. It is NOT the normal order of assembling the transmission.

① **DIRECT DRIVE INPUT SHAFT** This shaft is splined into the damper assembly in the converter cover and into the hub of the direct clutch cylinder ②. Thus, the shaft and clutch cylinder always turn at engine speed. The shaft is supported by the splines at each end.

② **DIRECT CLUTCH CYLINDER** — Supported by bushing B13 on the output shaft.

③ **TURBINE (TUBE) INPUT SHAFT** — Splined into the turbine hub and the forward clutch cylinder, this shaft drives the forward clutch cylinder and the reverse clutch hub at turbine (converter output) speed. It is supported by bushing B5 in the stator support and by B1 on the direct drive shaft.

④ **FORWARD CLUTCH CYLINDER** — Turns on the rear end of the stator support and is supported by the tube input shaft. It has internal splines for the forward clutch plates and external splines on the integral reverse clutch hub.

⑤ **OUTPUT SHAFT** — The shaft is supported by bushing B14 in the case and by the slip yoke and bushing B15 in the extension housing. Seal rings near the front of the shaft separate oil pressure passages for the governor and the direct clutch.

⑥ **RING GEAR** — Supported by the output shaft. The output hub is splined to the output shaft and to the ring gear. The external teeth in the ring gear are for engagement of the parking pawl in P range.

FORWARD CLUTCH AND PLANETARY GEARS

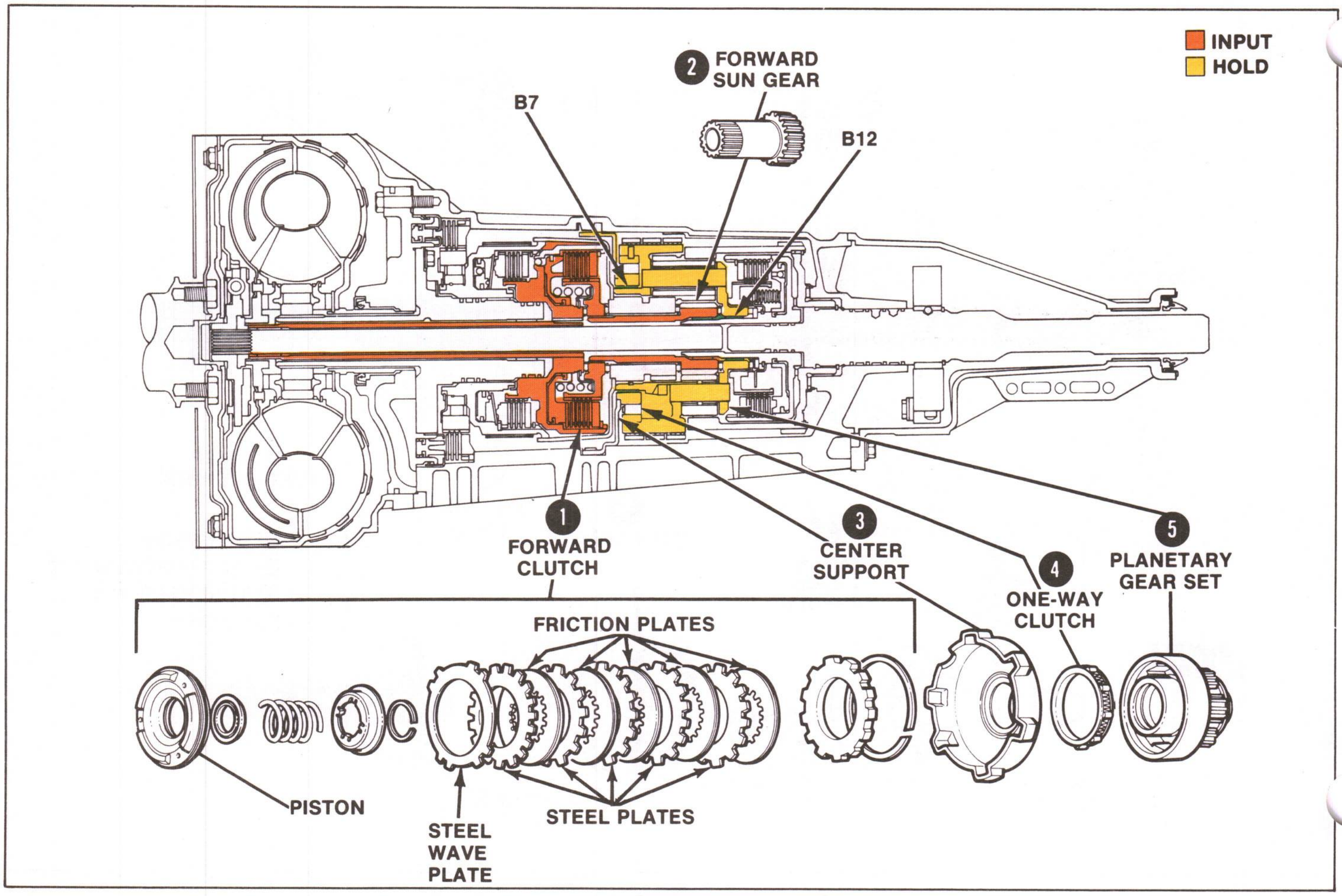


Figure 16 — Forward Clutch, Sun Gear, Planetary Gearset and One-Way Clutch

FORWARD CLUTCH INPUT DRIVE

Our next step now is to add the components necessary for first gear drive in O/D or 3 range. They are:

❶ Forward Clutch Pack

❷ Forward Sun Gear

❸ Center Support

❹ One-Way Planetary Clutch

❺ Planetary Gearset (Carrier and Pinions)

FORWARD CLUTCH ❶ and SUN GEAR ❷— — The forward clutch pack contains a hydraulic piston, alternating internally-splined and externally-splined plates, and a back-up pressure plate which is retained by a snap-ring. The internally-splined plates are splined to a driving hub; and the hub is splined onto the front of the forward sun gear ❷. The externally splined plates are splined to the forward clutch cylinder.

Thus, whenever there is hydraulic pressure on the clutch piston, the plates are squeezed together and the clutch cylinder is locked to the forward sun gear. The turbine (tube) input shaft then will drive the sun gear at turbine speed.

The forward sun gear is supported by bushing B11 and the direct clutch cylinder hub.

❸ **CENTER SUPPORT** — The center support is splined to the case. It has a hub protruding rearward that is in the inner race of the planetary one-way clutch. It also supports the planet carrier.

❹ **ONE-WAY CLUTCH** — A roller type one-way clutch is installed so that it will prevent the planet carrier from turning counterclockwise. If the unit is turning clockwise, the clutch overruns or free-wheels.

❺ **PLANETARY GEARSET** — The planet carrier is supported by bushing B7 at the center support, and by B12 at the rear.

With the short pinions in mesh with the forward sun gear and the long pinions in mesh with the output shaft ring gear, we now have all the components necessary for first gear drive.

FIRST (LOW) GEAR IN Ⓓ OR 3 RANGE

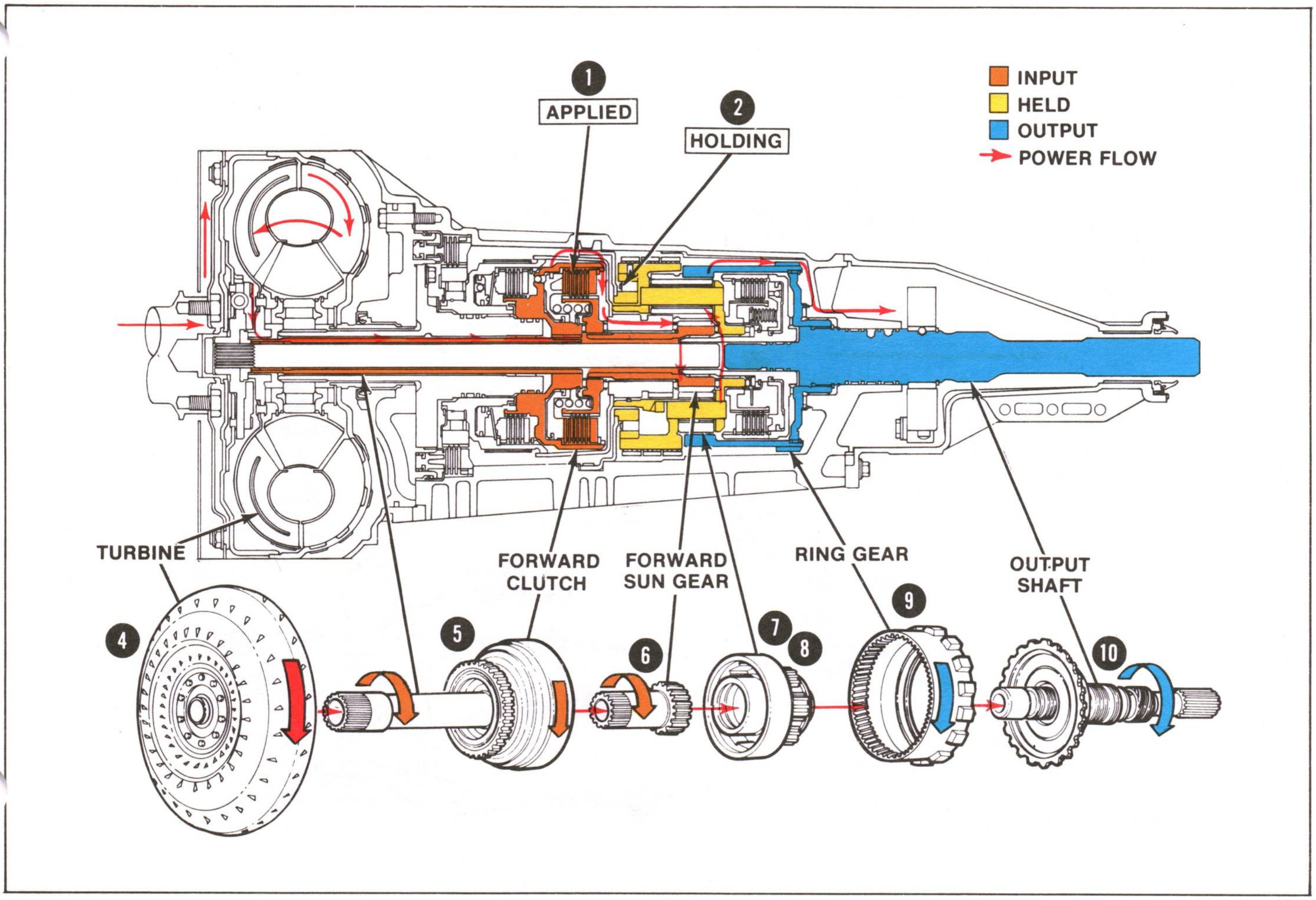


Figure 17 — First Gear Power Flow

HOLDING MEMBERS

In first gear in either overdrive or third range, the holding members are (Figure 17):

① **FORWARD CLUTCH** — Locks the turbine shaft to the forward sun gear.

② **PLANETARY (LOW) ONE-WAY CLUTCH** — Holds the planetary carrier from turning counterclockwise.

POWER FLOW AND ROTATION

Power flow and rotation are shown in Figures 17 and 18.

③ The engine drives the converter impeller clockwise.

④ The turbine is driven clockwise hydraulically.

⑤ The turbine shaft drives the forward clutch clockwise.

⑥ The clutch drives the forward sun gear clockwise.

⑦ The sun gear drives the short pinions counterclockwise.

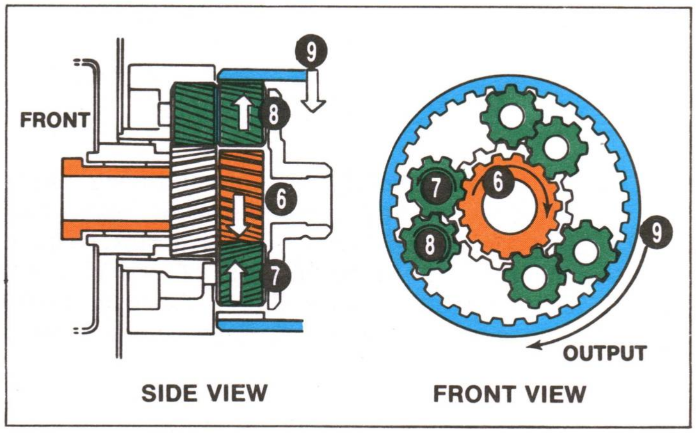


Figure 18 — Planet Gear Rotation in First Gear

⑧ The short pinions drive the long pinions clockwise.

⑨ The long pinions drive the ring gear clockwise at a reduced speed from the turbine shaft.

⑩ The ring gear drives the output shaft clockwise.

First gear is a 2.4-to-1 reduction. If the torque converter is in full reduction, the combined torque multiplication ratio is about 5-to-1.

LOW-REVERSE BAND AND MANUAL LOW GEAR

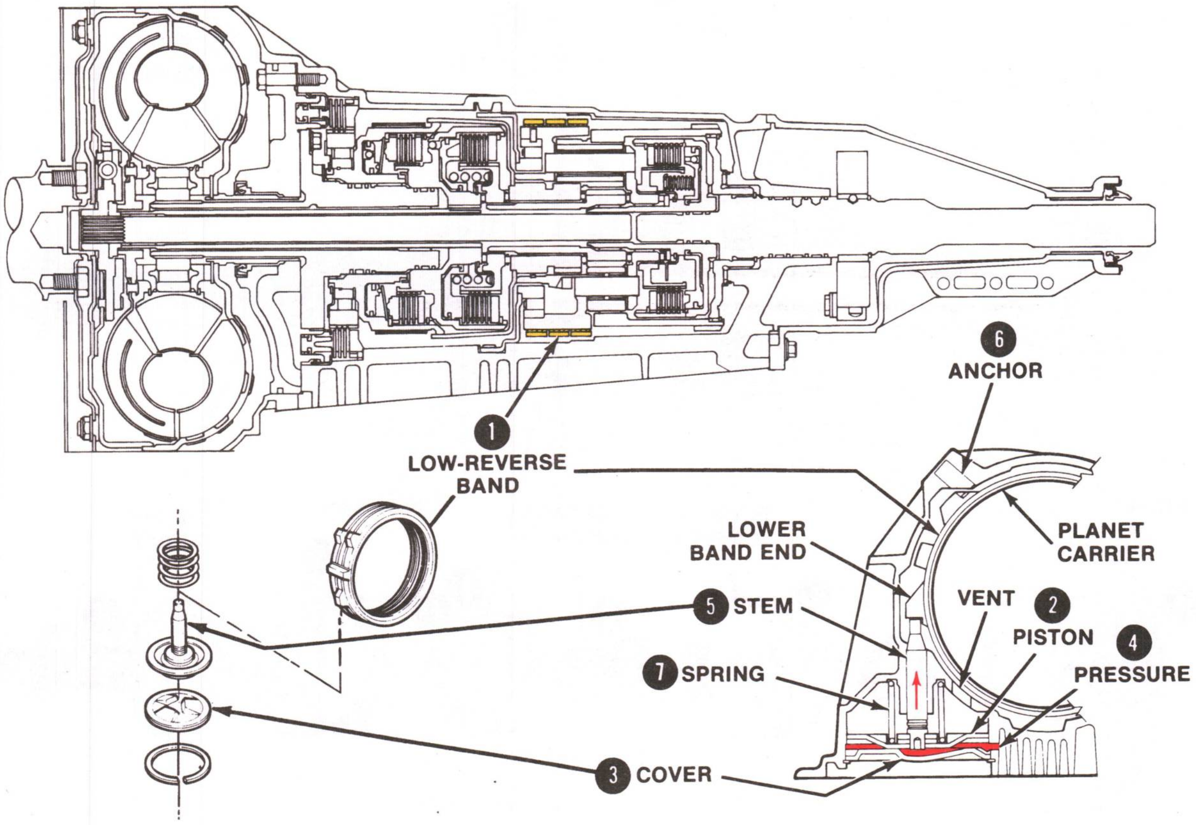


Figure 19 — Low-Reverse Band and Servo

BAND AND SERVO

First gear as just described for the normal driving ranges uses the planetary one-way clutch to hold the planet carrier. Coasting down, the one-way clutch overruns, so there is no "engine braking" in the first gear of overdrive and third ranges. To provide engine braking in range one (manual low), let's now add the low-reverse band and servo (Figure 19).

① The band is installed around the outer drum surface of the planet carrier.

② A spring-loaded servo piston is installed in the case.

③ The servo cavity is sealed with a cover, which provides a reaction area for hydraulic pressure.

④ Pressure is applied in first gear of range 1 and in R.

⑤ The piston and its stem are forced upward by the pressure.

⑥ One end of the band is anchored. Therefore, movement of the piston and stem against the lower band end causes the band to tighten around the carrier drum.

⑦ The spring returns the piston to release the band when pressure is released.

MANUAL LOW POWER FLOW

Power flow is identical to O/D or 3 range power flow as shown on the preceding page. The only difference in operation is that the band prevents the carrier from turning clockwise in the coasting situation, so that engine braking is available.

INTERMEDIATE CLUTCHES AND REVERSE SUN GEAR

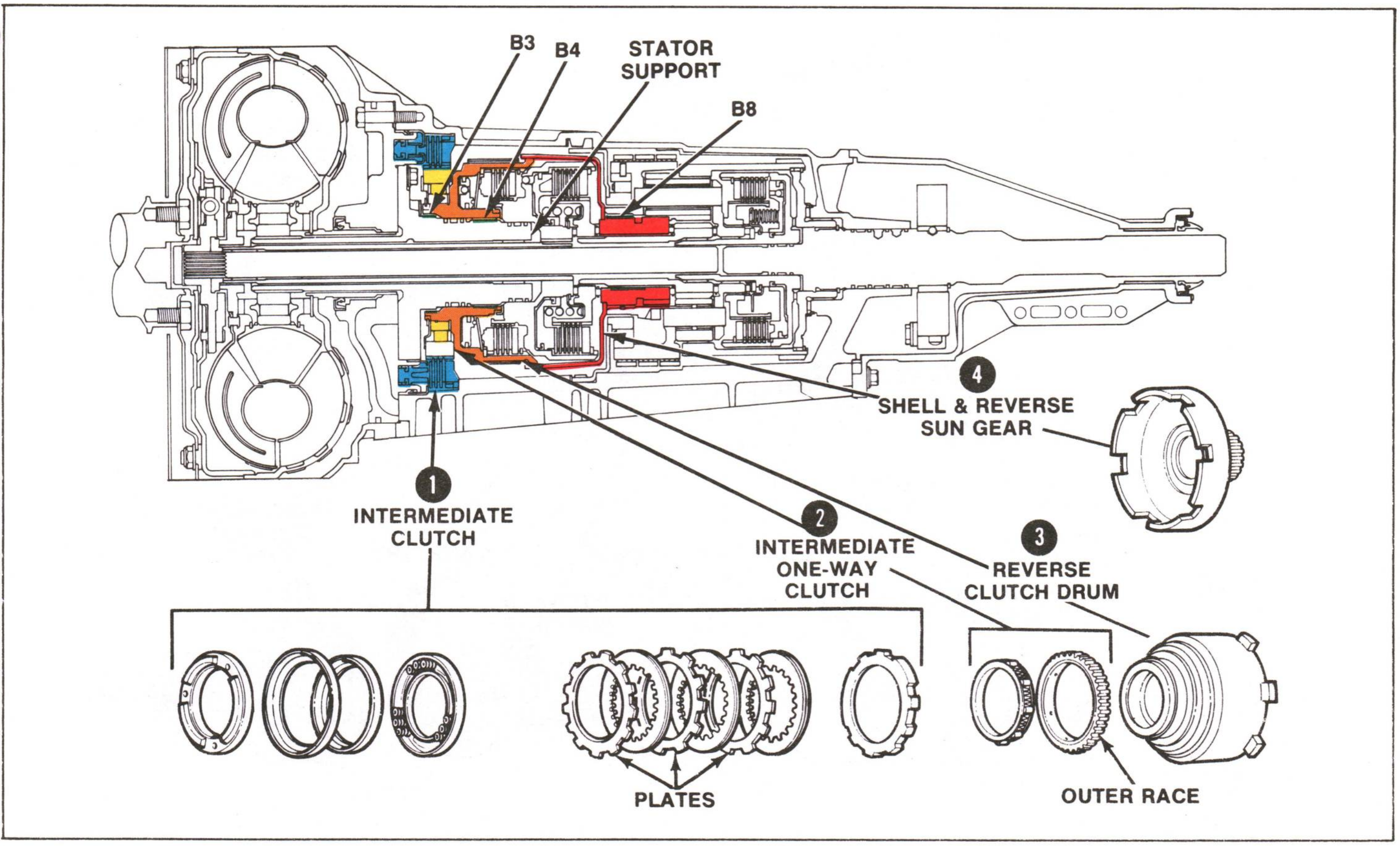


Figure 20 — Reverse Sun Gear and Holding Members

Continuing the build-up, let's now add the parts necessary for second gear (Figure 20):

① The Intermediate Clutch
② Intermediate One-Way Clutch
③ Reverse Clutch Drum
④ Shell and Reverse Sun Gear

①**INTERMEDIATE CLUTCH** — The intermediate friction clutch is installed with its piston in the rear of the oil pump housing and the plates in the case. The steel plates and the pressure plate splines are mated to case splines. The friction plates are splined to the outer race of the one-way clutch ② . When the clutch is applied by hydraulic pressure behind the piston, it holds the one-way clutch outer race stationary (locks it to the case).

②**ONE-WAY CLUTCH** — The intermediate one-way clutch is the caged roller type. Its inner race is locked onto the reverse clutch drum.

- If the reverse clutch drum tries to turn counterclockwise, the one-way clutch locks up and holds it stationary; provided, of course, that the intermediate clutch is applied.
- If the reverse clutch drum is turning clockwise, the one-way clutch overruns. This allows for "freewheeling" coasting down in second gear in O/D or 3 range. It also allows the intermediate clutch to remain applied in third and fourth gears.

③**SHELL AND REVERSE SUN GEAR** — The reverse (front) sun gear is integral with the input shell. Lugs on the reverse clutch drum mate with lugs on the shell. Thus:

- If the reverse clutch drum is held stationary, the reverse sun gear is also held stationary.
- If the reverse clutch drum is driven, it drives the sun gear.

BUSHING SUPPORTS

The reverse clutch drum is supported on the stator support by bushings B3 and B4. The reverse sun gear is supported on the carrier by bushing B8.

SECOND GEAR IN O/D OR 3 RANGE

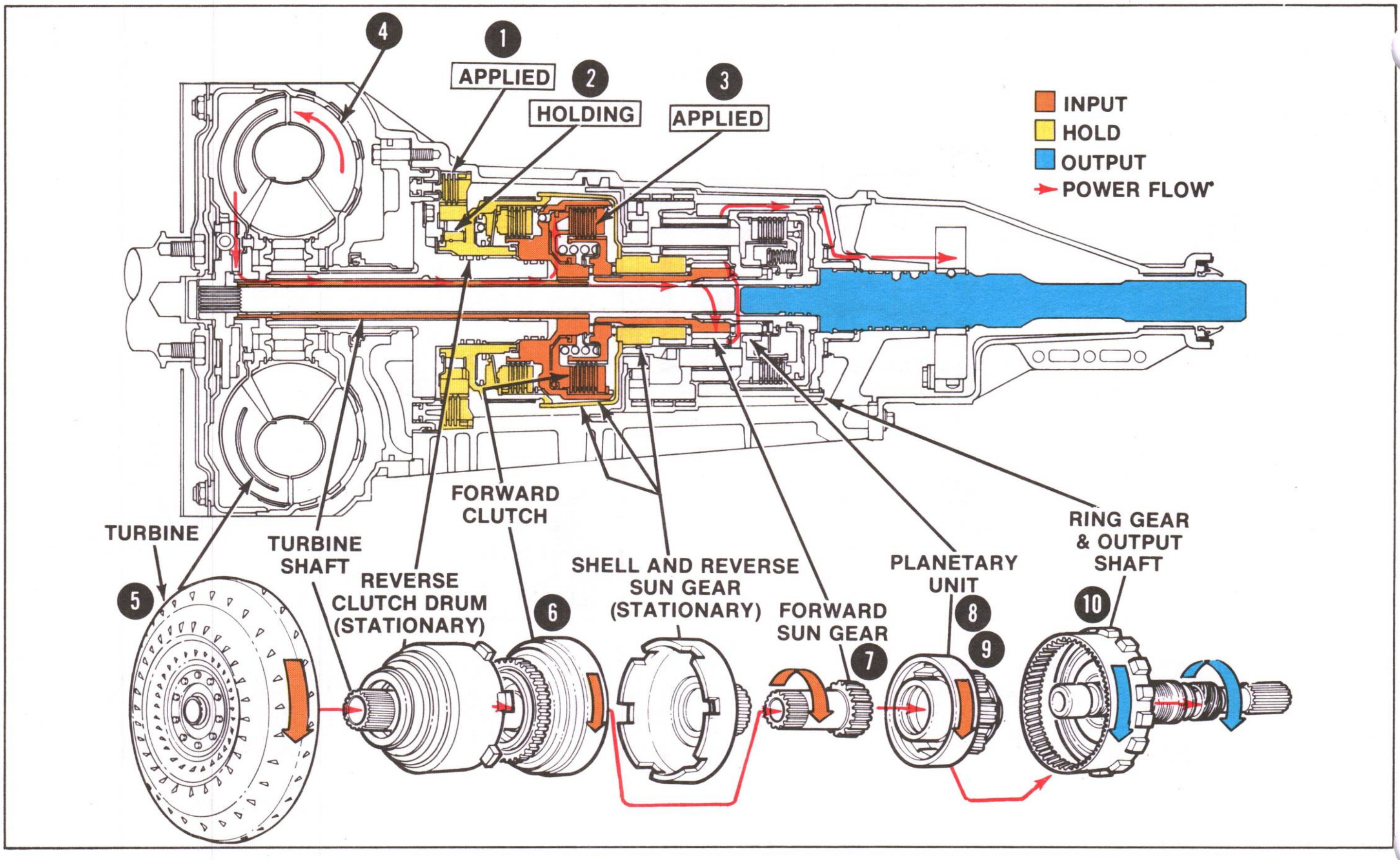


Figure 21 — Second Gear Power Flow

HOLDING MEMBERS

In second (intermediate) gear, in O/D and 3 ranges, the holding members (Figure 21) are:

❶ **INTERMEDIATE CLUTCH** — Locks the one-way clutch outer race stationary.

❷ **ONE-WAY CLUTCH** — Prevents the reverse clutch drum, shell and reverse sun gear from turning counterclockwise.

NOTE: Coasting in second gear in O/D or 3 range, the intermediate one-way clutch free-wheels. There is no engine braking.

❸ **FORWARD CLUTCH** — Locks the turbine shaft to the forward sun gear.

POWER FLOW AND ROTATION

Power flow and gear rotation are shown in Figures 21 and 22.

❹ The engine drives the converter impeller clockwise.

❺ The turbine is driven clockwise hydraulically

❻ The turbine shaft drives the forward clutch clockwise.

❼ The forward clutch drives the forward sun gear clockwise.

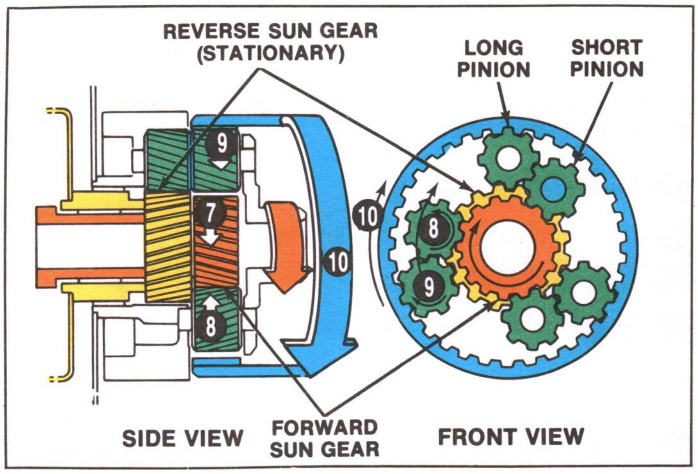


Figure 22 — Planet Gear Rotation in Second Gear

❽ The forward sun gear drives the short pinions in the planetary unit counterclockwise.

❾ The long pinion gears are driven clockwise and "walk" clockwise around the stationary reverse sun gear.

❿ The long pinions drive the ring gear and output shaft clockwise at a reduced speed.

Second gear has a 1.47-to-1 reduction from turbine shaft speed. Torque multiplication in the converter if any, can increase the total torque multiplication above 1.47-to-1.

REVERSE CLUTCH ASSEMBLY

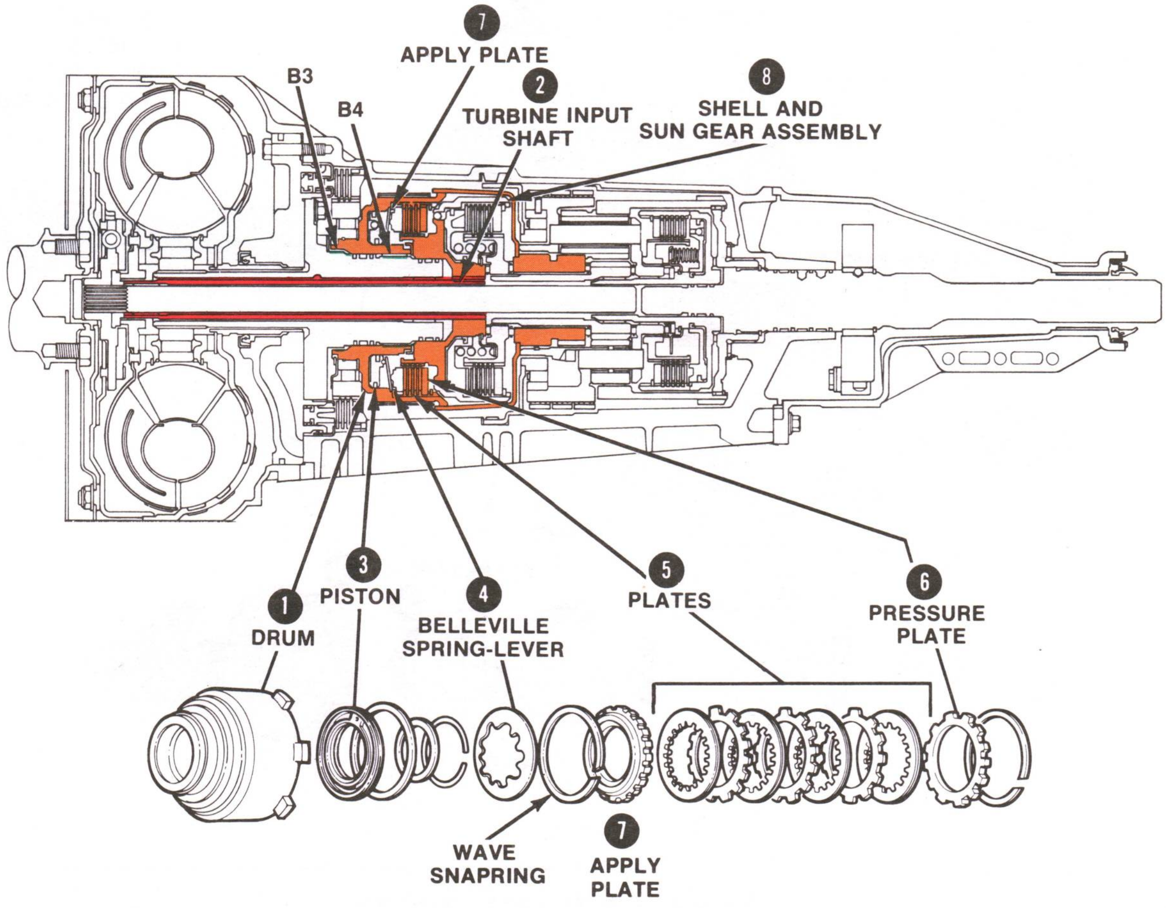


Figure 23 — Reverse Clutch Assembly

So far we have "built-up" the gear train far enough to show low and intermediate gear power flow. Since direct and overdrive involve mechanical input from the direct drive shaft, let's skip them for a moment and go on to reverse gear. Reverse, remember, also is driven hydraulically, that is, from the torque converter turbine.

REVERSE CLUTCH

The low-reverse servo has already been covered. So we need only to add the reverse clutch assembly (Figure 23) to be able to show reverse power flow.

The drum ①, we already know about, since it was involved in **holding** the reverse sun gear in second gear. But now, we want to see how it **drives** the reverse sun gear.

So first, recall that the **hub** for the reverse clutch is integral with the forward clutch cylinder, which is permanently joined to the turbine input shaft ②

The reverse clutch piston ③ is applied by hydraulic pressure through a passage in the stator support. It moves rearward against a Belleville spring ④, which forces the clutch plates ⑤ against each other and against the pressure plate ⑥. This is the only Belleville type spring in the automatic overdrive clutches, and it operates as a lever through an apply plate ⑦ . (The other clutches are directly applied by their pistons and released by coil springs.)

DRIVING THE REVERSE SUN GEAR

When the reverse clutch is applied, the turbine input shaft ② is coupled to the clutch drum ① . The drum, of course, is locked to the shell and sun gear assembly ⑧ . So when this clutch is applied, the reverse sun gear will be driven at turbine speed.

REVERSE GEAR

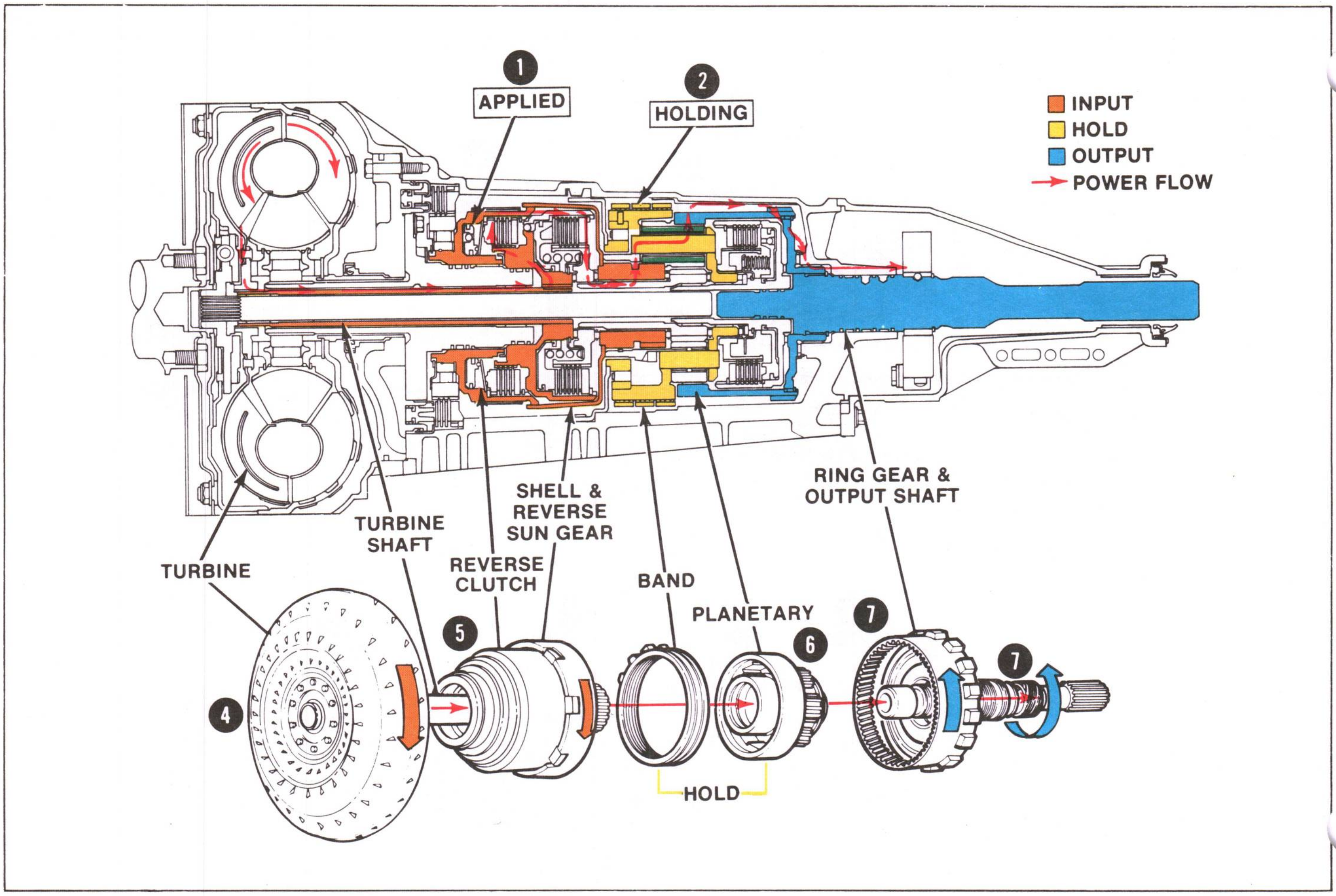


Figure 24 — Reverse Gear Power Flow

HOLDING MEMBERS

In reverse gear (Figure 24), the holding members are:

① **REVERSE CLUTCH** — Locks the turbine input shaft to the reverse sun gear.

② **LOW-REVERSE BAND** — Holds the planet carrier stationary.

POWER FLOW AND ROTATION

Power flow and gear rotation for reverse are shown in Figures 24 and 25.

③ The engine drives the converter impeller clockwise.

④ The turbine is driven clockwise hydraulically.

⑤ The turbine shaft drives the reverse clutch, the shell and the reverse sun gear clockwise.

⑥ The reverse sun gear drives the long planet pinions counterclockwise.

⑦ The long planet pinions drive the ring gear and output shaft counterclockwise.

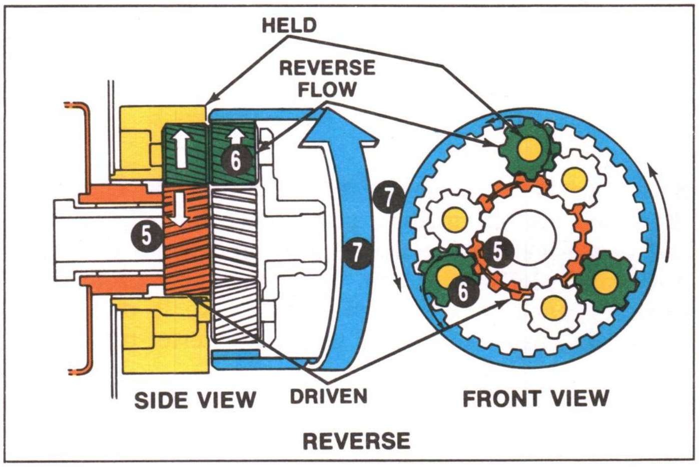


Figure 25 — Planet Gear Rotation in Reverse

NOTE: The short planet pinions and forward sun gear also turn but are not involved in the power flow.

The long planet pinions, in effect, are reverse idler gears. The gear reduction is to a 72-tooth ring gear from a 36-tooth sun gear; or a 2-to-1 gear ratio.

If the torque converter is also in full torque multiplication, the combined ratio in reverse is about 4-to-1.

DIRECT CLUTCH AND MECHANICAL INPUT

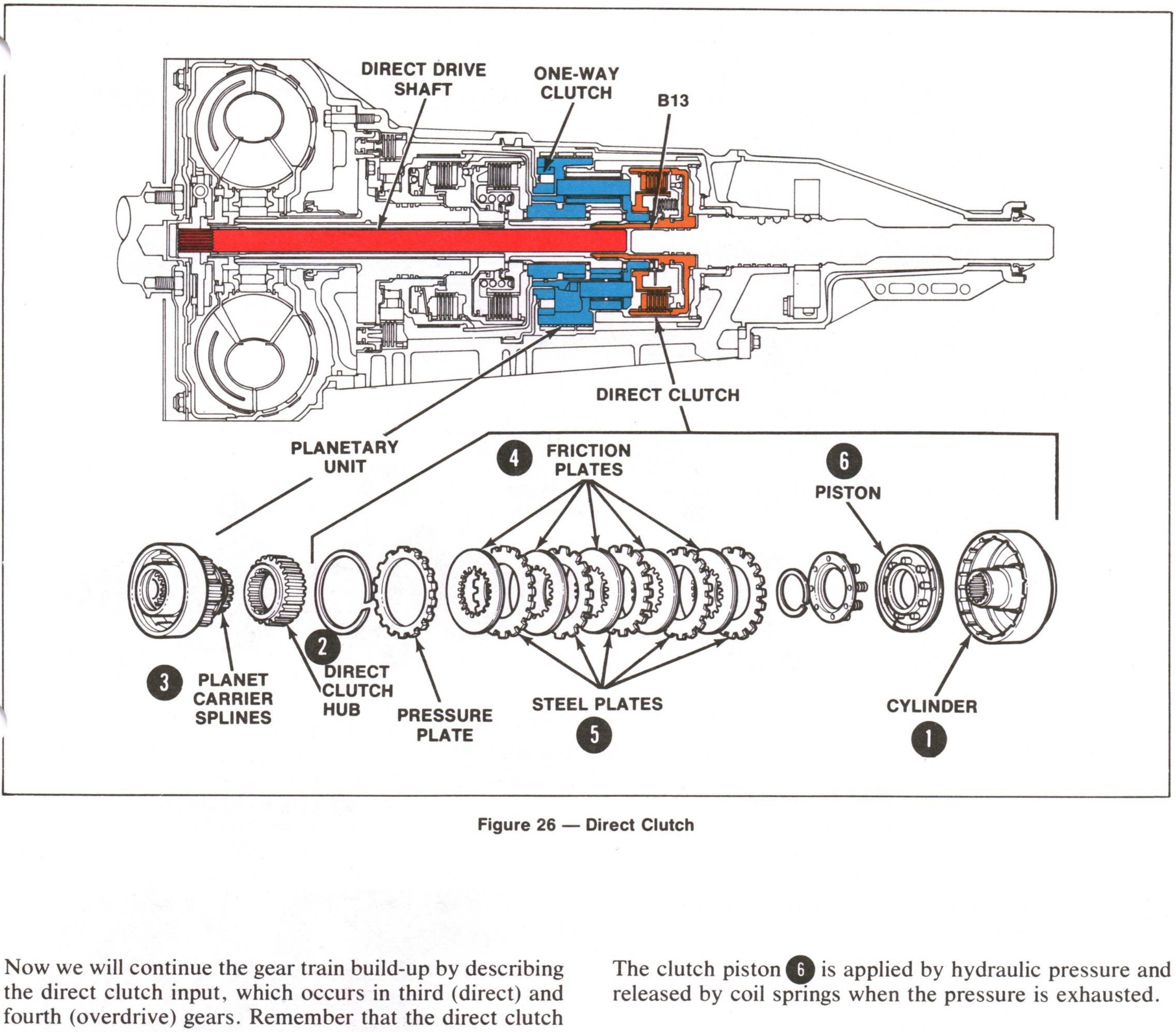


Figure 26 — Direct Clutch

Now we will continue the gear train build-up by describing the direct clutch input, which occurs in third (direct) and fourth (overdrive) gears. Remember that the direct clutch cylinder (drum) is driven mechanically through the direct drive input shaft (Figure 26), rather than by the turbine input shaft.

DIRECT CLUTCH

The direct clutch cylinder ❶ is supported by bushing B13, and is splined to the direct drive input shaft. Therefore, it always turns at engine speed. However, it does not transmit any power to the gear train until the clutch is applied.

Power to the gear train is through the hub ❷. This hub is splined to external splines ❸ on the rear of the planet carrier. Friction plates ❹ are splined on the exterior of the hub. Steel plates ❺, including a pressure plate, are splined into the direct clutch cylinder.

The clutch piston ❻ is applied by hydraulic pressure and released by coil springs when the pressure is exhausted.

DRIVES THE PLANETARY UNIT

From this, we can see that anytime the direct clutch is applied, the direct drive input shaft will drive the planet carrier assembly clockwise at engine speed, by-passing the turbine.

The planetary (low) one-way clutch overruns when the direct clutch is applied. (Remember that it is installed to hold the carrier assembly from turning counterclockwise only.)

As mentioned earlier, the direct clutch will handle about 60 percent of the total input torque in direct drive (third gear). In overdrive (fourth gear), it handles all the torque.

Let's look at third gear power flow now.

THIRD GEAR (DIRECT DRIVE)

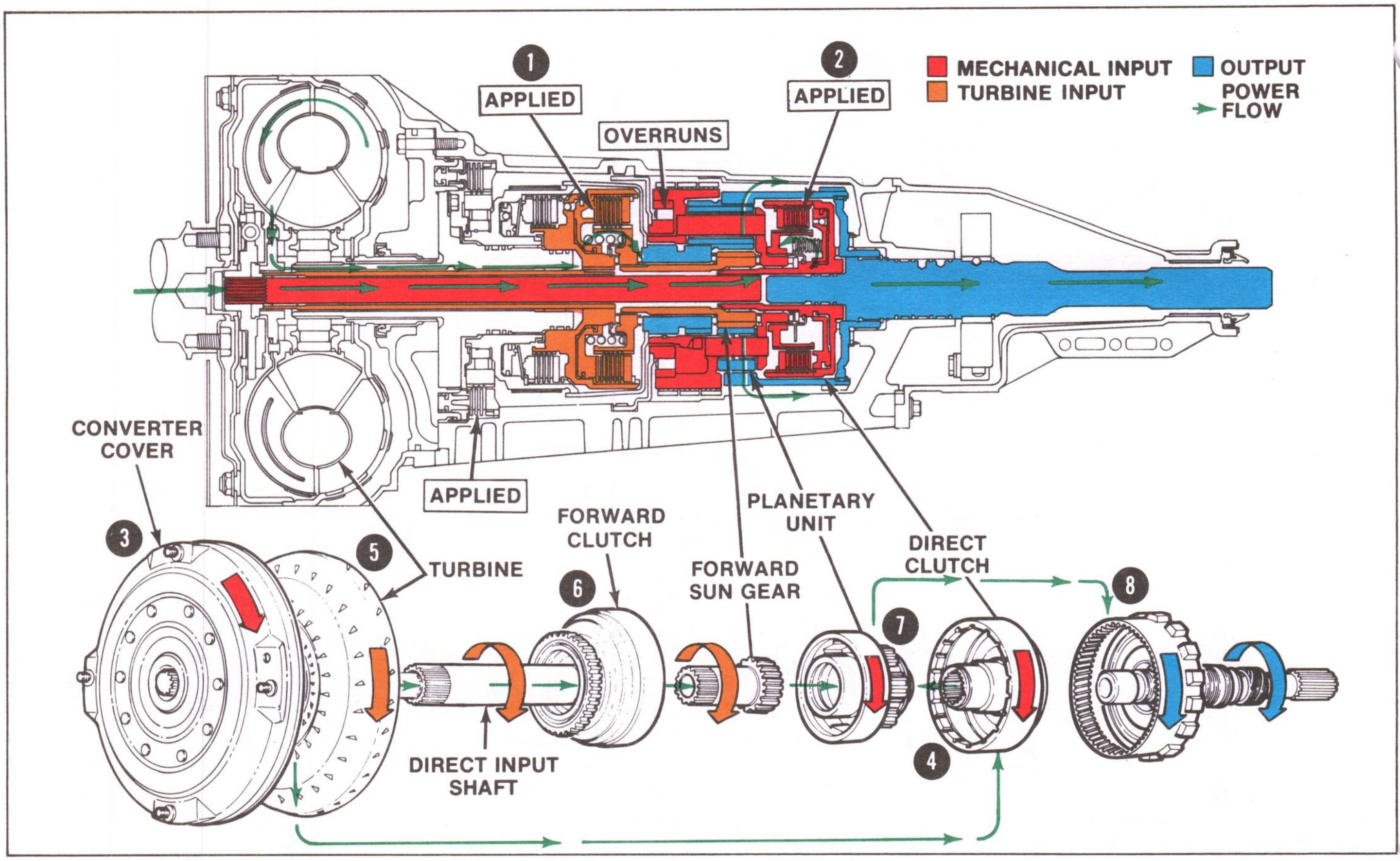


Figure 27 — Third Gear Power Flow

HOLDING MEMBERS

In third gear (direct drive), the holding members (Figure 27) are:

❶ **FORWARD CLUTCH** — Locks the turbine (tube) input shaft to the forward sun gear.

❷ **DIRECT CLUTCH** — Locks the direct drive input shaft to the planet carrier assembly.

POWER FLOW AND ROTATION

Remember the principle that, when any two members of a planetary gear system are locked together and driven, the **entire** system will turn as a unit. This is effectively what we are illustrating in Figures 27 and 28.

❸ The converter cover drives the direct drive shaft and the direct clutch at engine speed.

❹ The direct clutch drives the planet carrier at engine speed.

❺ The turbine is driven hydraulically at almost engine speed; but let's pretend that it is the same as engine speed for this illustration.

❻ The turbine shaft drives the forward clutch and the forward sun gear.

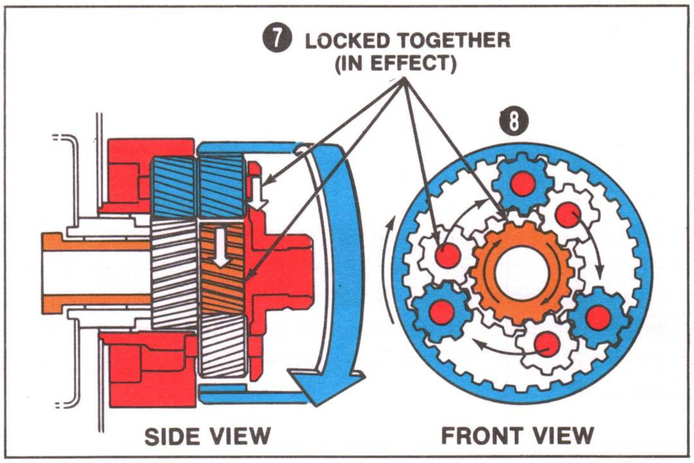


Figure 28 — Planet Gear Rotation in Direct Drive

❼ With two members of the planetary unit being driven at the same time, they are (in effect) locked together so the entire gearset "locks up" and rotates as a unit.

❽ The long pinions drive the output shaft in direct drive.

THERE IS SOME CONVERTER SLIP

In actual fact, there is some slight slip in the converter in direct drive. Thus, the planetary pinions do turn on their shafts and within the ring gear to a slight degree. But for all practical purposes, the planetary system is locked up and the drive ratio is 1-to-1.

OVERDRIVE BAND AND SERVO

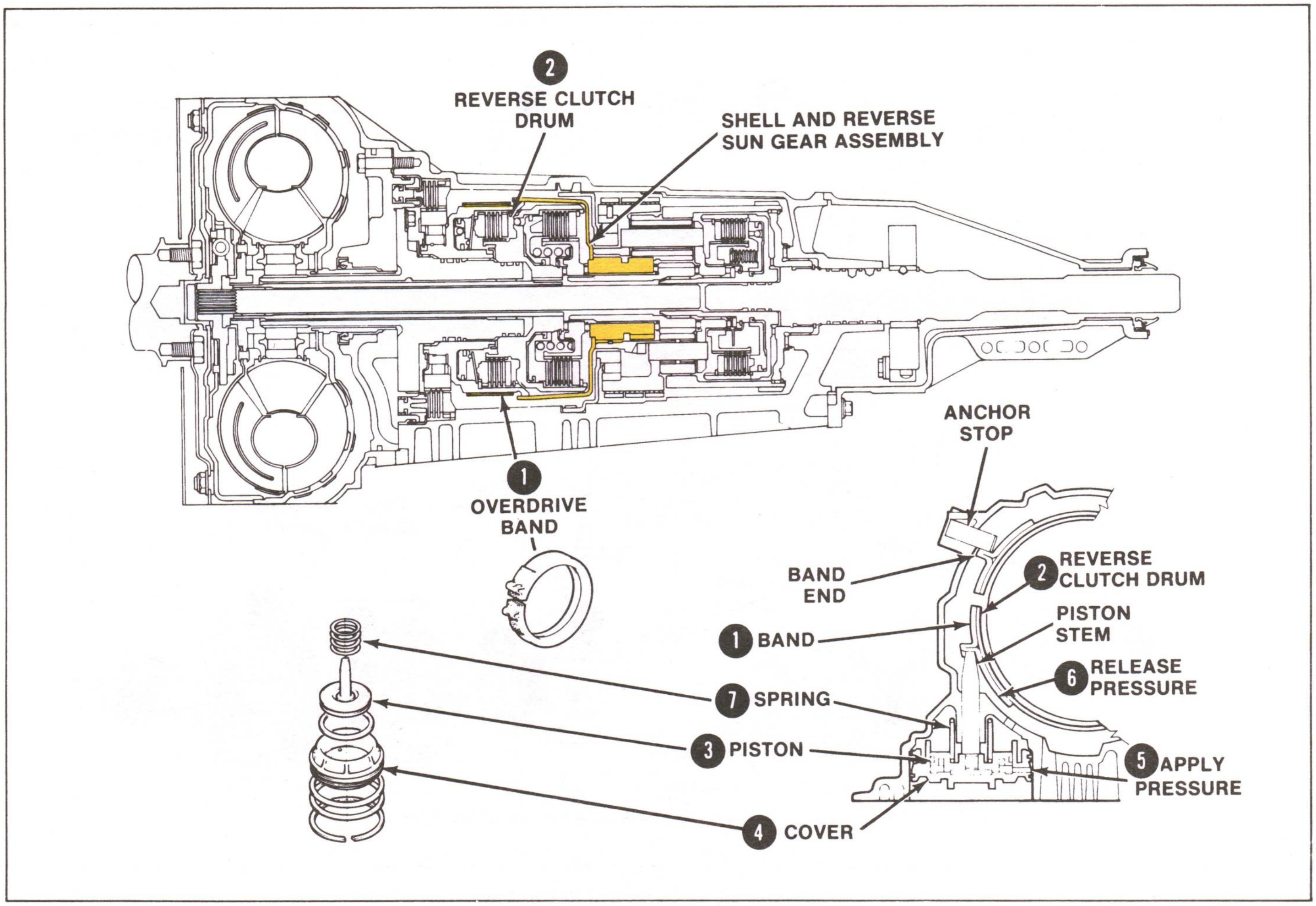


Figure 29 — Overdrive Band and Servo

OVERDRIVE BAND

Now the addition of the overdrive band ① and band servo will complete the build-up of the gear train (Figure 29).

The band is installed around the drum ② of the reverse clutch. When the band is applied, it holds the drum from rotation in either direction. And you'll remember that, when this drum is stationary, it also holds the shell and reverse sun gear assembly stationary. The band is applied in overdrive, and in second gear in range 1.

OVERDRIVE SERVO

Like the low-reverse servo, the overdrive servo is installed in a pocket in the lower part of the case.

As shown in the lower right of Figure 29, the band and servo operation are as follows:

① The band has one end against the servo piston stem and the other against an anchor stop.

② The reverse clutch drum will be locked from turning when the piston is forced up to apply the band.

③ A spring-loaded servo piston is fitted within a cover in the case.

④ The cover provides a reaction area for apply pressure.

⑤ Applied pressure moves the piston up to tighten the band around the drum.

⑥ Release pressure is applied to the opposite side of the piston.

NOTE: Anytime sevo release is pressurized, the servo is not applied.

⑦ A release spring assists the release pressure.

FOURTH GEAR (OVERDRIVE)

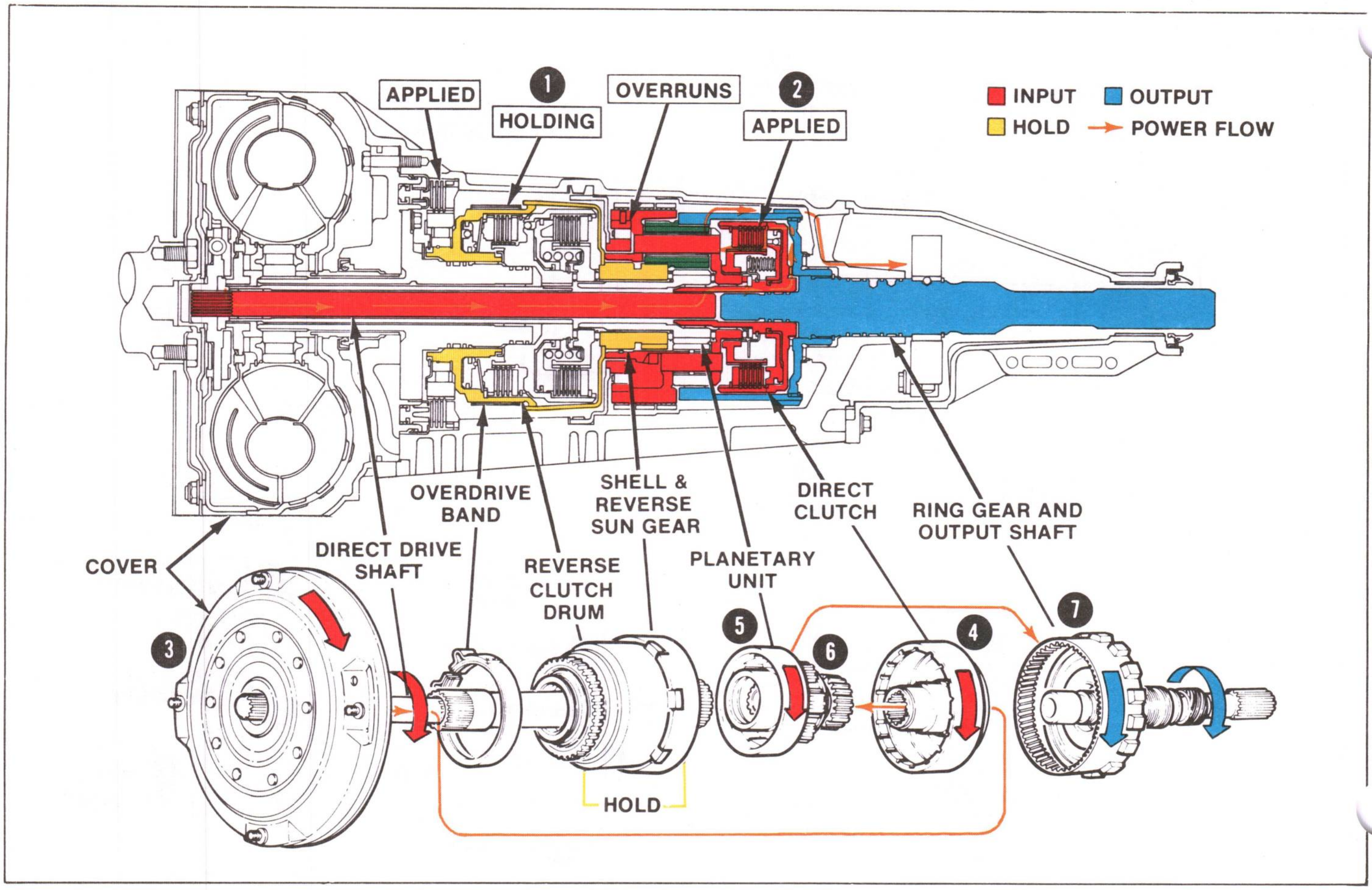


Figure 30 — Overdrive Power Flow

HOLDING MEMBERS

In overdrive or fourth gear, the holding members are (Figure 30):

❶ **OVERDRIVE BAND** — Locks the reverse sun gear stationary through the reverse clutch drum and driving shell.

❷ **DIRECT CLUTCH** — Couples the planet carrier assembly to the engine.

POWER FLOW AND GEAR ROTATION

Overdrive is accomplished by holding a sun gear and driving the pinion carrier, as was described at the start of this section. The power flow and rotation are shown in Figures 30 and 31.

❸ The converter cover drives the direct drive shaft clockwise at engine speed.

❹ The direct drive shaft drives the direct clutch.

❺ The direct clutch drives the planet carrier assembly; still clockwise at engine speed.

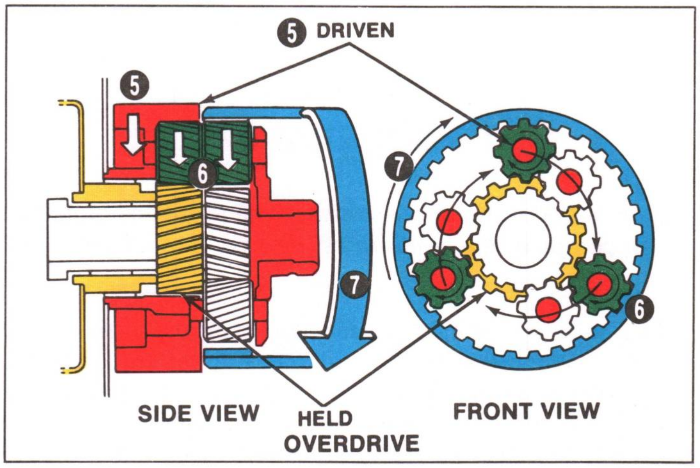


Figure 31 — Planet Gear Rotation in Overdrive

❻ The **long** planet pinions "walk around" the stationary reverse sun gear, in a clockwise direction.

❼ The ring gear and output shaft are driven at a faster speed by the rotation of the long planet pinions.

In overdrive, the gear ratio is 0.667-to-1. Since the input is 100 percent mechanical drive, there is no converter slip. Thus overdrive gear offers maximum opportunity for fuel economy at cruising speeds.

NEUTRAL AND PARK POWER FLOW

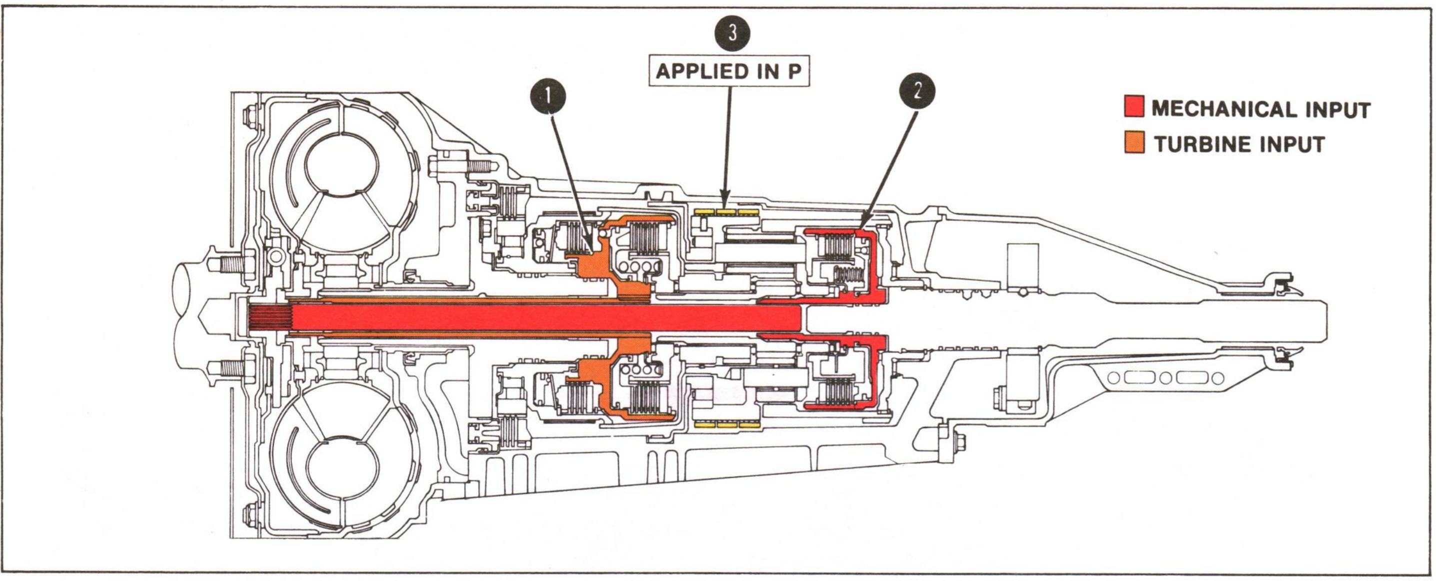


Figure 32 — Neutral and Park Power Flow

In Neutral and Park, there is power flow into the transmission, but no power out, since all the clutches are disengaged. See Figure 32.

❶ The turbine shaft drives the forward clutch cylinder only.

❷ The direct drive input shaft drives the direct clutch cylinder only.

❸ In Park, the low-reverse band is applied, but does not cause any drive condition.

THRUST WASHERS AND NEEDLE BEARINGS

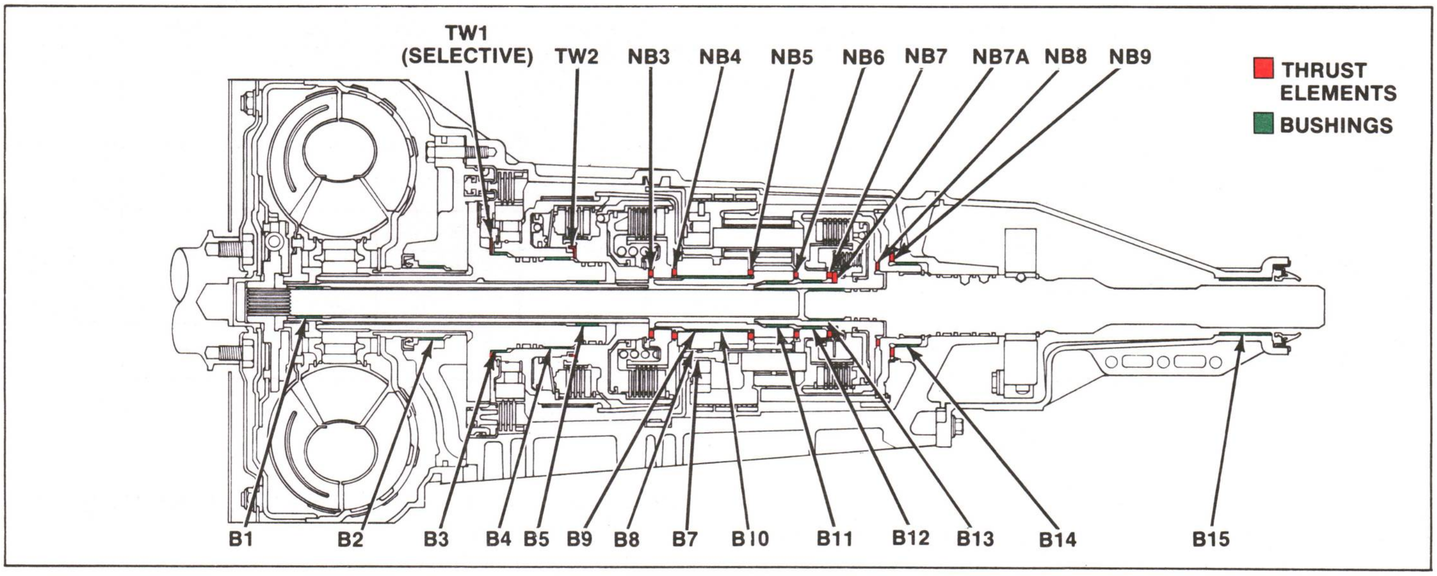


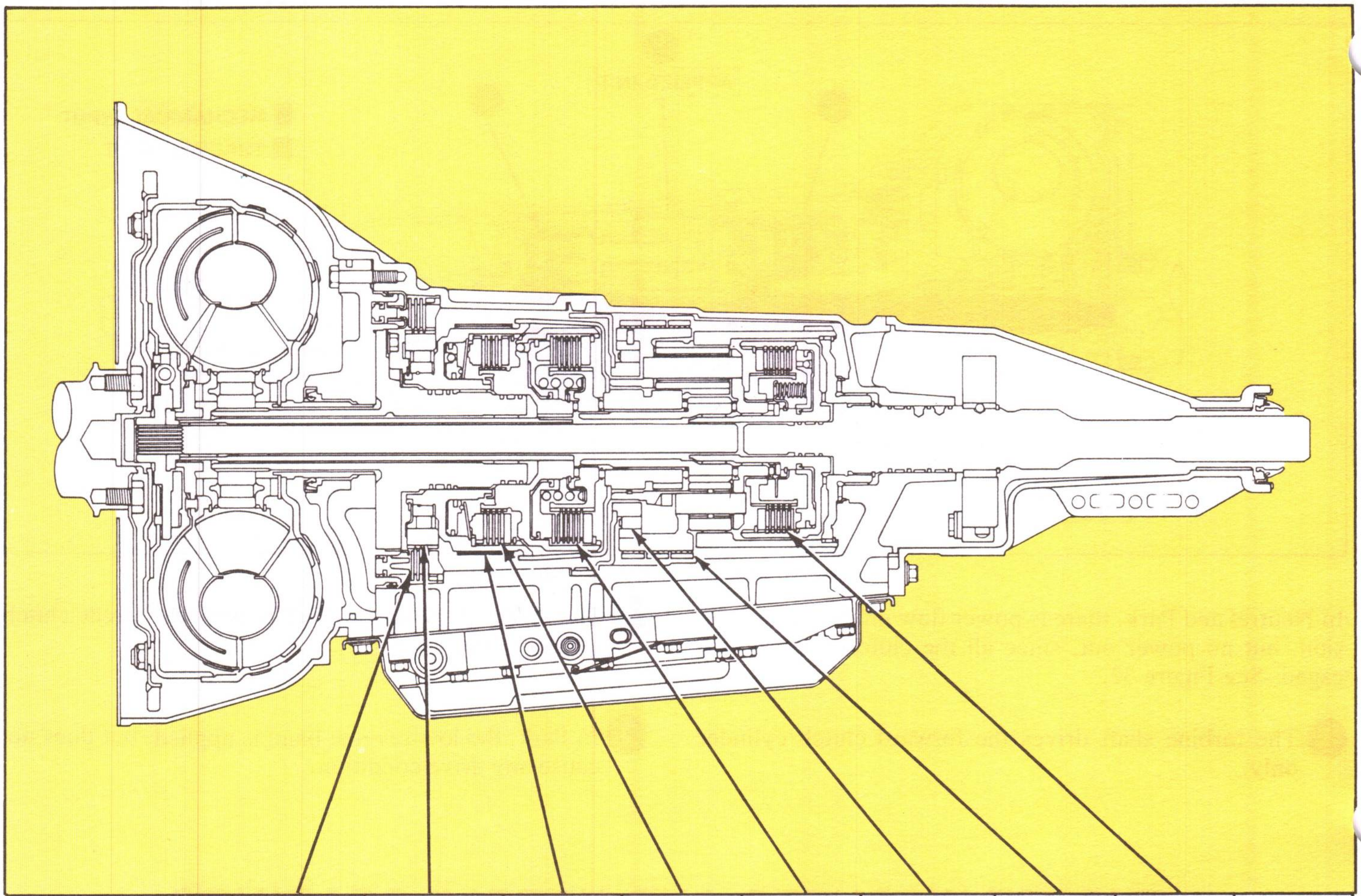
Figure 33 — Transmission Thrust Elements

There are two thrust washers and seven needle thrust bearings (Figure 33) in the automatic overdrive transmission drive train. They are used to provide smooth bearing surfaces where the gear train components rotate face-to-face. In addition there are thrust washers in the torque converter. (These are not numbered because the converter is not disassembled in service.)

The transmission has 14 bushings for bearing surfaces where parts rotate around one another. The major supporting bushings were identified in the build-up descriptions. Most of them are serviceable following the Shop Manual procedures.

NOTE: The illustration is labelled through B15. Bushing B6 has been eliminated.

SUMMARY OF CLUTCHES AND BAND OPERATION



Gear	Intermediate Friction Clutch	Intermediate Roller Clutch	Overdrive Band	Reverse Clutch	Forward Clutch	Planetary (Low) One-Way Clutch	Low and Reverse Band	Direct Clutch	* Gear Ratio
1 Range Low					APPLIED	HOLDING	APPLIED		2.4-to-1
O/D and 3 Range Low					APPLIED	HOLDING			2.4-to-1
Second (Intermediate)	APPLIED	HOLDING			APPLIED	OVERRUNS			1.467-to-1
Third (Direct)	APPLIED	OVERRUNS			APPLIED	OVERRUNS		APPLIED	1-to-1
Fourth (Overdrive)	APPLIED		APPLIED			OVERRUNS		APPLIED	0.667-to-1
Reverse				APPLIED			APPLIED		2-to-1

*Not including torque converter reduction in 1st, Second and Reverse.

Figure 34 — Band and Clutch Application Chart

To conclude this section, let's look at a summary of the band and clutch application in the various gears (Figure 34). The chart can be very helpful in troubleshooting slip or slow engagement conditions.

For example, notice that the reverse clutch is applied only in reverse gear. Thus, it might be the cause of slip or slow engagement in reverse. Of course, the low-and-reverse band or servo could also cause these conditions.

Another example: the direct clutch is applied in third and overdrive. Slip in both those gears would probably be traced to that clutch.

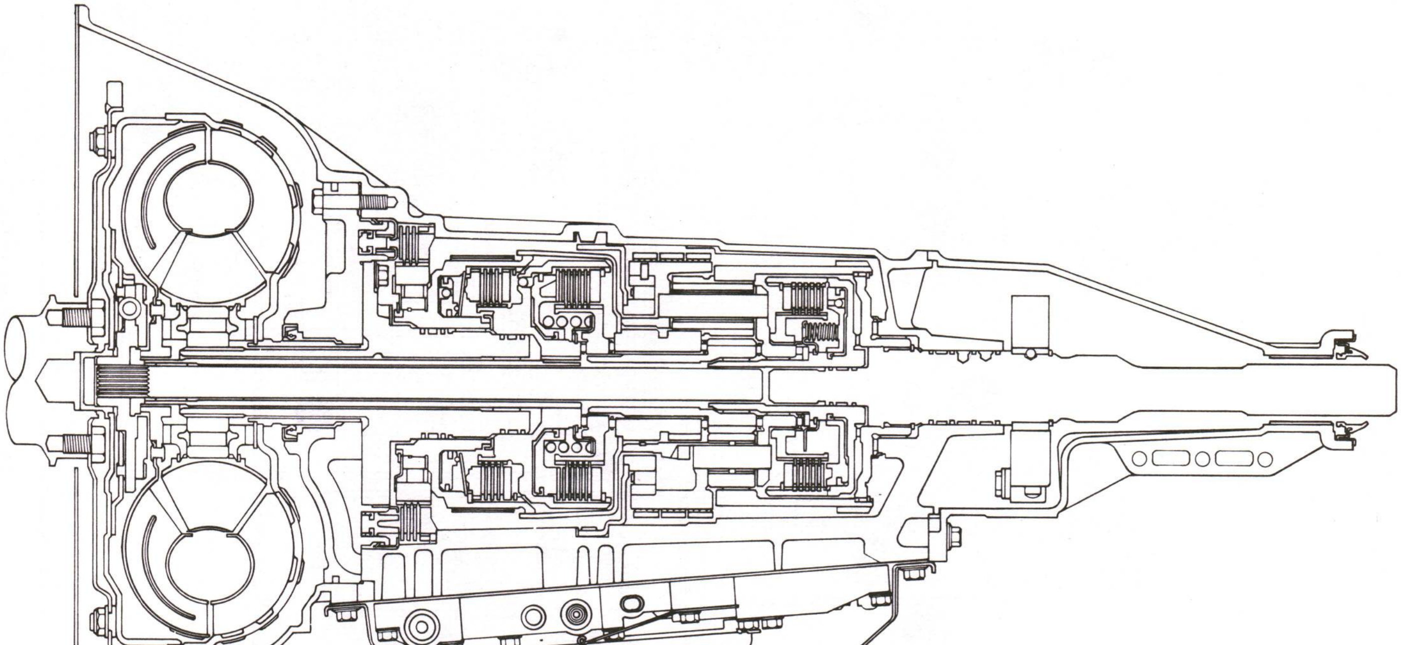
The Diagnosis section of this booklet will give you a more detailed analysis of various slip conditions and how to isolate the causes.

Notice that some blocks are colored, indicating the active holding members in each gear. Where there is no color in the block, the fact that a clutch is applied is only incidental.

AUTOMATIC OVERDRIVE TRANSMISSION

SECTION 4.

HYDRAULIC SYSTEM



OVERVIEW OF HYDRAULIC SYSTEM OPERATION

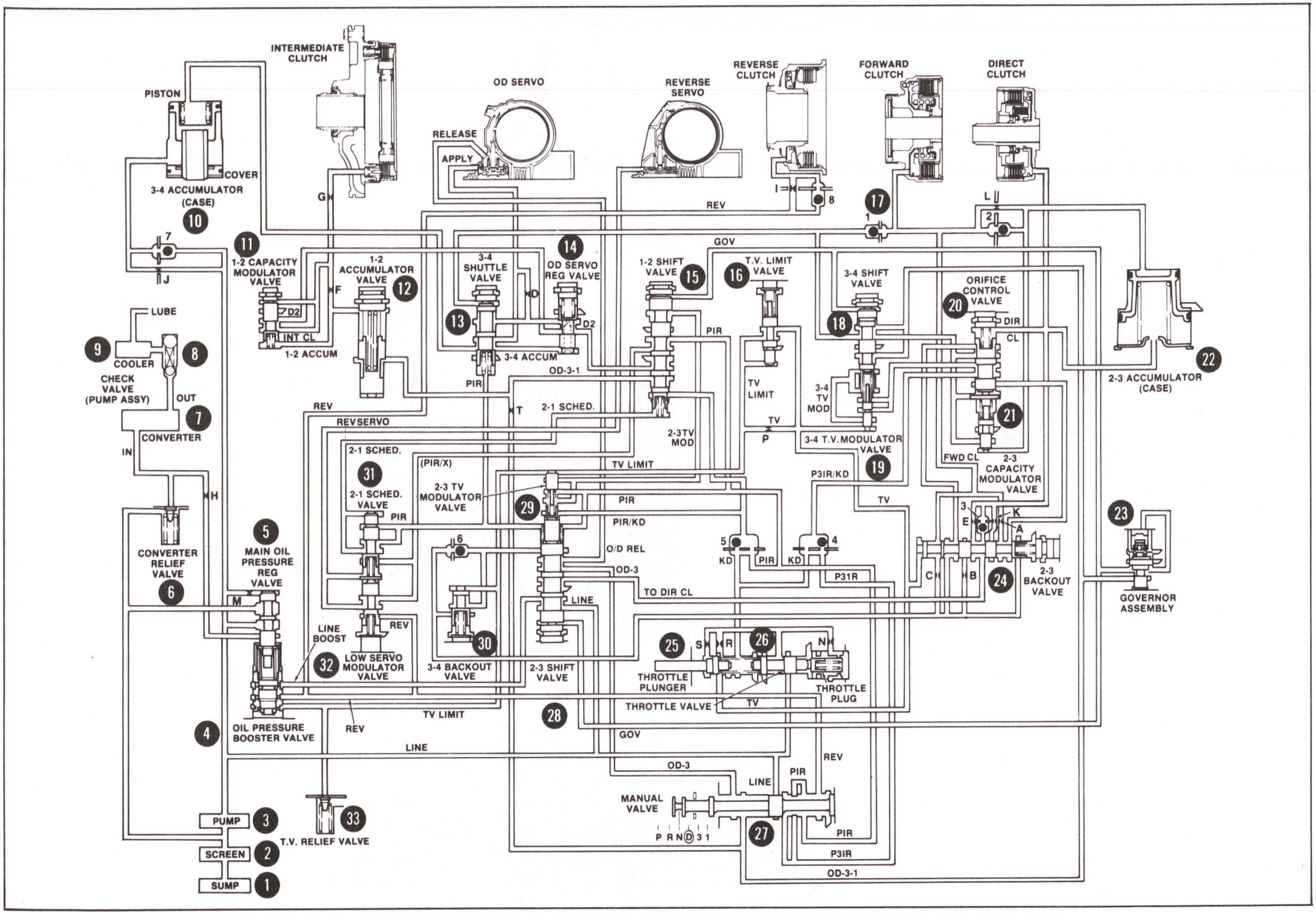


Figure 35 — Hydraulic System Schematic

FUNCTIONS OF HYDRAULIC SYSTEM

The hydraulic system of the automatic overdrive transmission has several functions:

- Supply fluid for torque converter operation.
- Direct fluid under pressure to apply band servos and clutches.
- Lubricate the transmission parts.
- Remove heat generated by vortex flow in the torque converter and by other parts of the transmission.

In this section, as we did with the gear train, we will "build up" the hydraulic system, showing how the principal sub-systems and components work. Then, in the next section, we will describe the full system operation in various driving modes.

HYDRAULIC SYSTEM SCHEMATIC

It will be necessary in these sections to represent the hydraulic system schematically. Also, we will sometimes be required to mention a component before its operation has been fully explained. Therefore, referring to the schematic (Figure 35) and the valve body illustration (Figure 36), we will first identify all the components with a brief mention of their functions.

Notice that the schematic has the valves arranged in the same positions they are installed in the valve body. (Any component that is not contained in the valve body assembly will be illustrated **only** in Figure 35 at this point.

MAIN COMPONENTS

The main components are identified on the illustrations by circled key numbers. Please refer to those numbers as you study the following:

①**SUMP** — The transmission oil pan contains a supply of hydraulic fluid for the system.

②**SCREEN** — Protects the pump inlet from dirt and other foreign material that may cling to the fluid.

③**OIL PUMP** — Pumps hydraulic fluid to the system when the engine is running.

④**OIL PRESSURE BOOSTER VALVE** — Increases or decreases main control pressure in relation to throttle opening. Also provides different main control pressures depending on range or gear ratio.

⑤**MAIN REGULATOR VALVE** — Regulates main (line) control pressure in the system.

⑥**CONVERTER RELIEF VALVE** — Prevents excess pressure build-up in the torque converter.

⑦**CONVERTER** — Fluid clutch and torque multiplier (as described earlier).

⑧**CHECK VALVE** — Prevents oil in the converter from draining back when the engine is shut down.

⑨**COOLER** — Removes heat generated in the torque converter and transmission.

NOTE: Cooler return fluid is used for lubrication before it returns to the sump ①.

⑩**3-4 ACCUMULATOR** — Cushions the 3-4 upshift by controlling the rate of application of the overdrive servo.

NOTE: The clutches and servos are shown across the top of the schematic. Their operation was described in the preceding section and will not be repeated here.

⑪**1-2 CAPACITY MODULATOR VALVE** — AND . . .

⑫**1-2 ACCUMULATOR VALVE** — Operate together to smooth the 1-2 upshift.

⑬**3-4 SHUTTLE VALVE** — Controls operation of the O.D. servo regulator valve and 3-4 accumulator.

⑭**O.D. SERVO REGULATOR VALVE** — Determines the apply pressure for the overdrive servo on the 4-3 downshift.

⑮**1-2 SHIFT VALVE** — Controls automatic 1-2 upshift and 2-1 downshift.

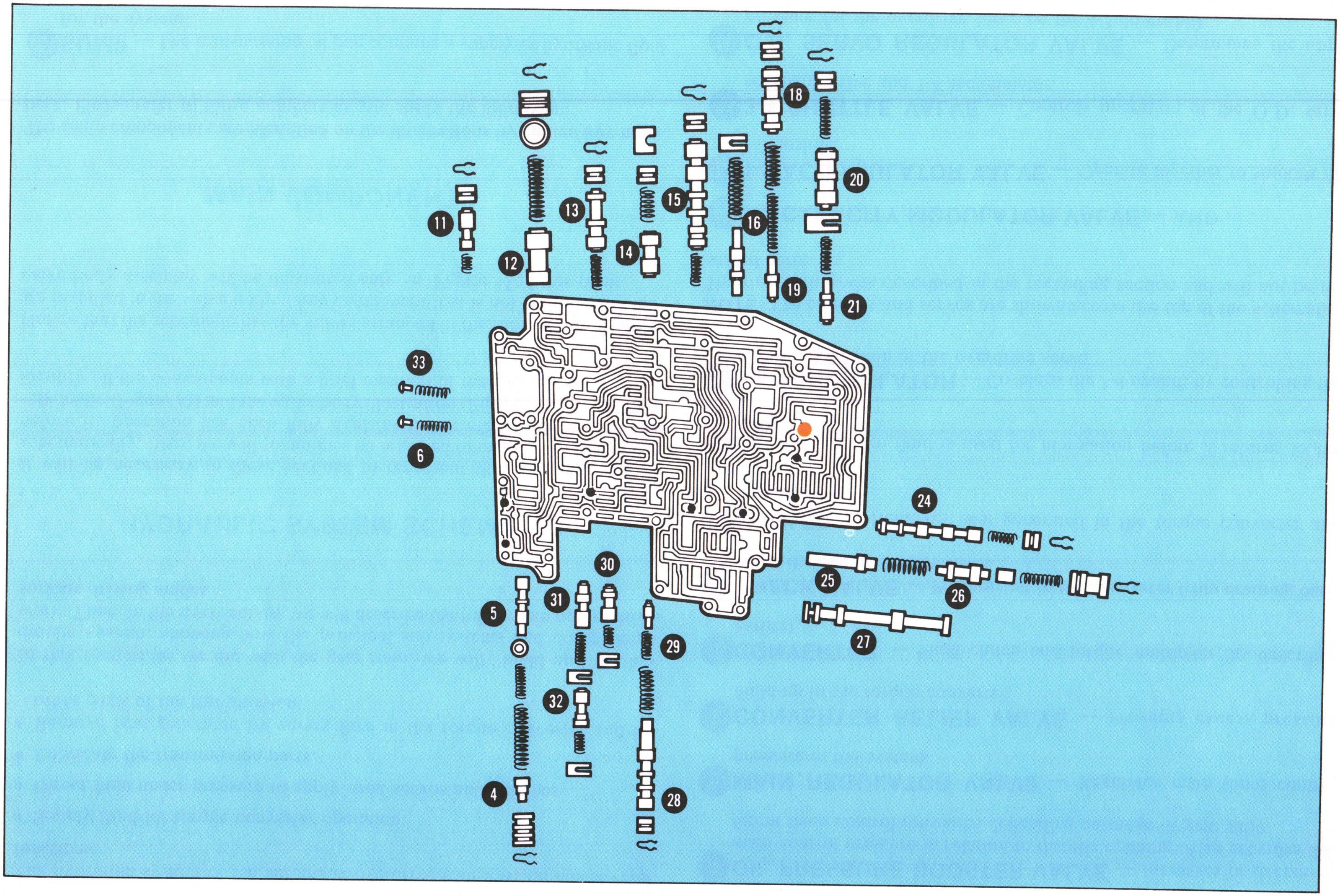


Figure 36 — Valve Body Exploded View

⑯ **T.V. LIMIT VALVE** — Limits throttle pressure acting on the pressure booster valve ④ and on the 2-3 shift valve ㉘ by regulating T.V. pressure at wide open throttle.

⑰ **CHECK VALVE** — There are eight ball check valves in this valve body. They are used as shuttle valves or one-way valves.

⑱ **3-4 SHIFT VALVE** — Controls automatic 3-4 upshift and 4-3 downshift.

⑲ **3-4 T.V. MODULATOR VALVE** — Modulates throttle valve (T.V.) pressure acting on the 3-4 shift valve.

⑳ **ORIFICE CONTROL VALVE** — Prevents the transmission from shifting out of second gear directly into overdrive. Also works with the 2-3 backout valve.

㉑ **2-3 CAPACITY MODULATOR VALVE** — Controls backpressure on the 2-3 accumulator to smooth the 2-3 upshift.

㉒ **2-3 ACCUMULATOR** — Cushions direct clutch application for a smooth 2-3 upshift. Also cushions forward clutch for a smooth initial engagement.

㉓ **GOVERNOR** — Provides a road speed signal to the hydraulic system.

㉔ **2-3 BACKOUT VALVE** — Controls the feed rate of the direct clutch. Also operates with orifice control valve ⑳ to control the feed rate of the forward clutch.

㉕ **THROTTLE PLUNGER** — Varies spring force on throttle valve with throttle opening. Also operates "kickdown" system at wide-open throttle.

㉖ **THROTTLE CONTROL VALVE** — Regulates throttle pressure as an engine load signal to the hydraulic system.

㉗ **MANUAL VALVE** — Moves with the shift selector and directs control pressure to various passages to apply clutches and servos, and to provide automatic functions of the hydraulic system.

㉘ **2-3 SHIFT VALVE** — Controls automatic 2-3 upshift and 3-2 downshift.

㉙ **2-3 T.V. MODULATOR VALVE** — Modulates throttle valve (T.V.) pressure acting on the 2-3 shift valve and the 1-2 shift valve.

㉚ **3-4 BACKOUT VALVE** — Smooths the 3-4 upshift if it occurs at closed throttle.

㉛ **2-1 SCHEDULING VALVE** — Determines 2-1 downshift speed when the shift selector is moved to manual low from direct or overdrive range.

㉜ **LOW SERVO MODULATOR VALVE** — Regulates low-and-reverse servo apply pressure for a smooth 2-1 downshift in manual low range.

㉝ **T.V. RELIEF VALVE** — Prevents excess T.V. limit pressure if the T.V. limit valve ⑯ fails to regulate properly.

With that brief description of what each component has to do, we can now proceed to describe the hydraulic components and sub-systems in detail.

FLUID FLOW PASSAGES IN TRANSMISSION

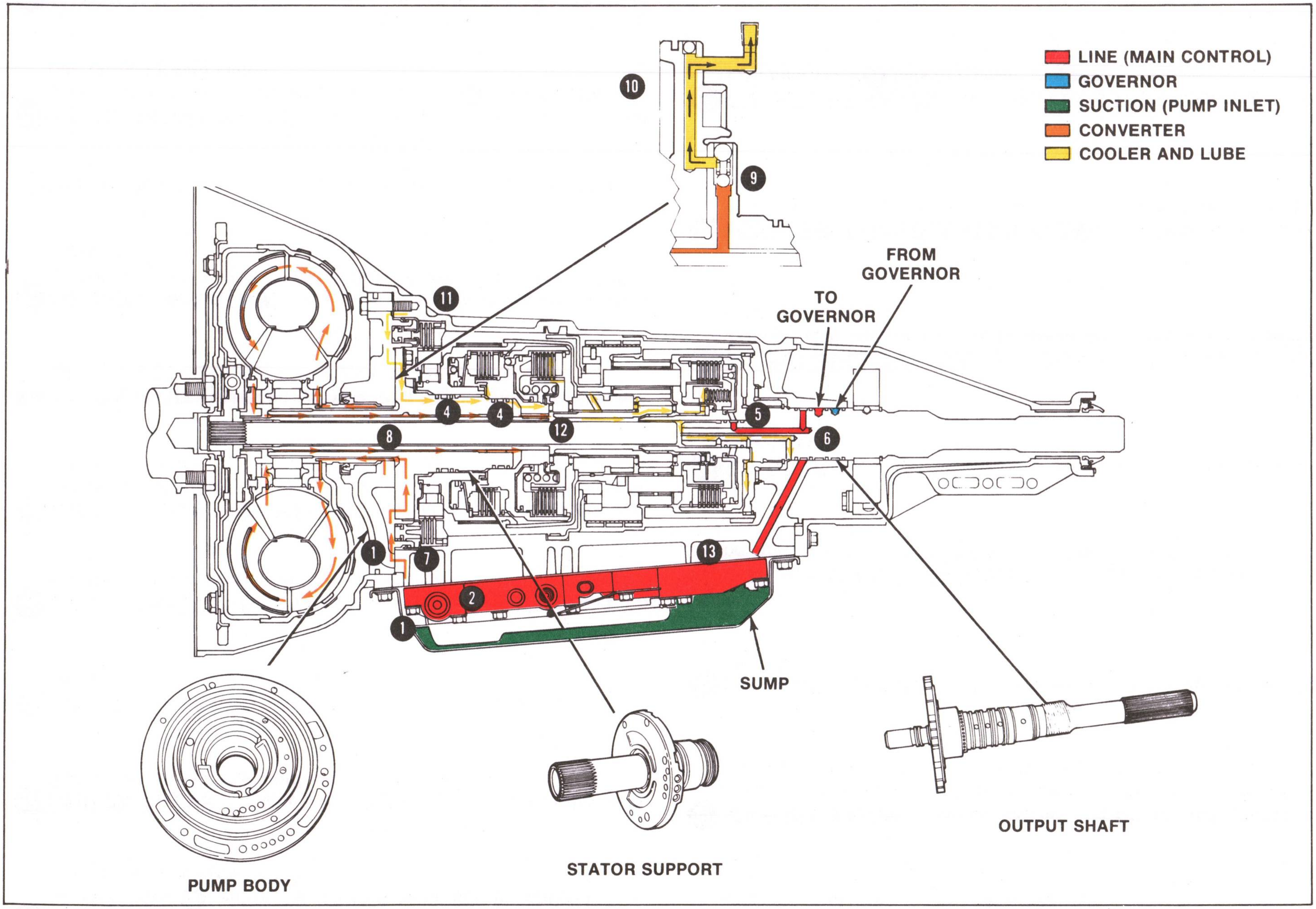


Figure 37 — Fluid Flow Passages

Let's look now at the principal fluid flow passages in the automatic overdrive transmission, following the numbered key in Figure 37:

❶ Fluid from the sump flows through passages in the case and pump body to the pump inlet.

❷ Fluid from the pump returns, under pressure, into case and the valve body.

❸ Intermediate clutch apply pressure is routed back through the case and pump body.

❹ Apply pressure for the reverse and forward clutches is routed through the case, pump and stator support.

❺ Direct clutch apply pressure is routed through the rear of the case and through sealed passages in the output shaft.

❻ The governor also is fed line (control) pressure through the output shaft. Governor pressure (blue) returns through the shaft to the valve body.

❼ Converter supply fluid is routed through the case and pump body to the inside of the pump-driving hub on the impeller.

❽ Converter discharge fluid flows between the turbine input shaft and stator support, then to . . .

❾ The check valve in the pump body.

❿ A passage from the pump body then leads to the cooler-in port on the side of the case. All fluid from the converter goes through the cooler.

⓫ Return fluid from the cooler enters another port in the case; then flows back to the pump body.

⓬ The fluid then flows through the stator support and through the gear train for lubrication.

⓭ Lubrication fluid drains through the bottom of the case and back to the sump.

With that background, we can now begin to "build-up" the hydraulic system.

THE OIL PUMP AND THE FLUID

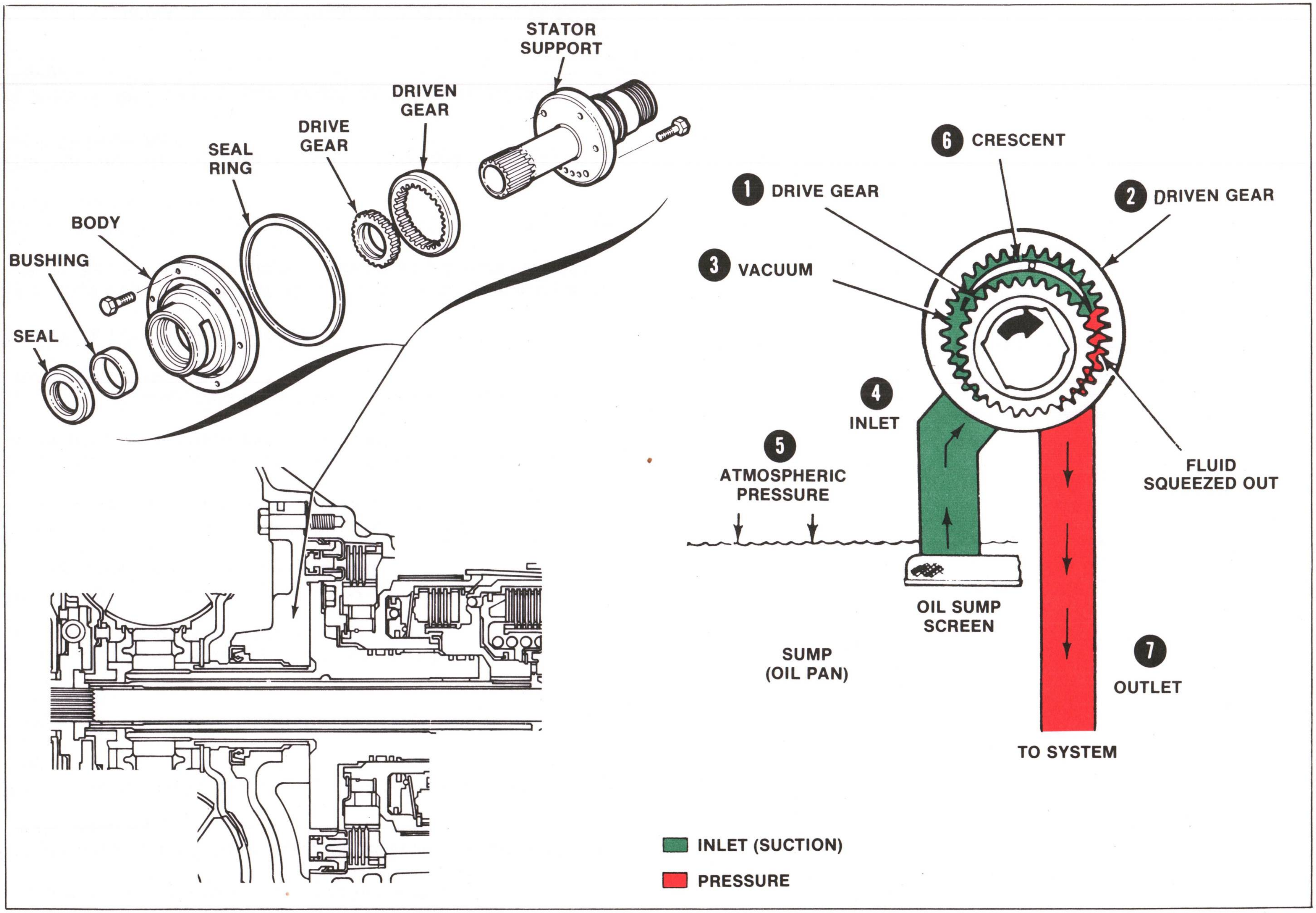


Figure 38 — Oil Pump Operation

Let's begin our build-up of the automatic overdrive transmission hydraulic system by considering the source of pressurized oil or fluid — the oil pump used to put the fluid into motion. Then we will describe the valves involved in regulating the pressure, and the basic supply circuits.

The transmission is supplied with enough fluid to keep the torque converter completely filled, to operate the hydraulic controls, and to lubricate the working parts. After these needs are met, there is still a reserve of fluid stored in the oil pan and bottom of the case. This "storehouse" is usually called the sump (Figure 38).

HOW THE OIL PUMP WORKS

The oil pump (Figure 38) is an internal-gear design. The drive gear ❶ is driven by the "flats" on the converter impeller hub.

As the pump drive gear ❶ is driven by the impeller, it causes the internal driven gear ❷ to rotate also. Where the gears separate from mesh, a vacuum ❸ is created, and here is where we locate the pump inlet ❹. Atmospheric pressure ❺ in the sump forces fluid into the inlet through the sump screen.

At the point of greatest separation, the gears are closely fitted to a crescent ❻ in the pump housing. The crescent and the space between the gear teeth form chambers in which the fluid is trapped as the gears turn past the inlet. Beyond the crescent, the gears begin to come together again. Since the crescent seals the fluid from getting back to the inlet, it now must be squeezed out the outlet port ❼ and into the system.

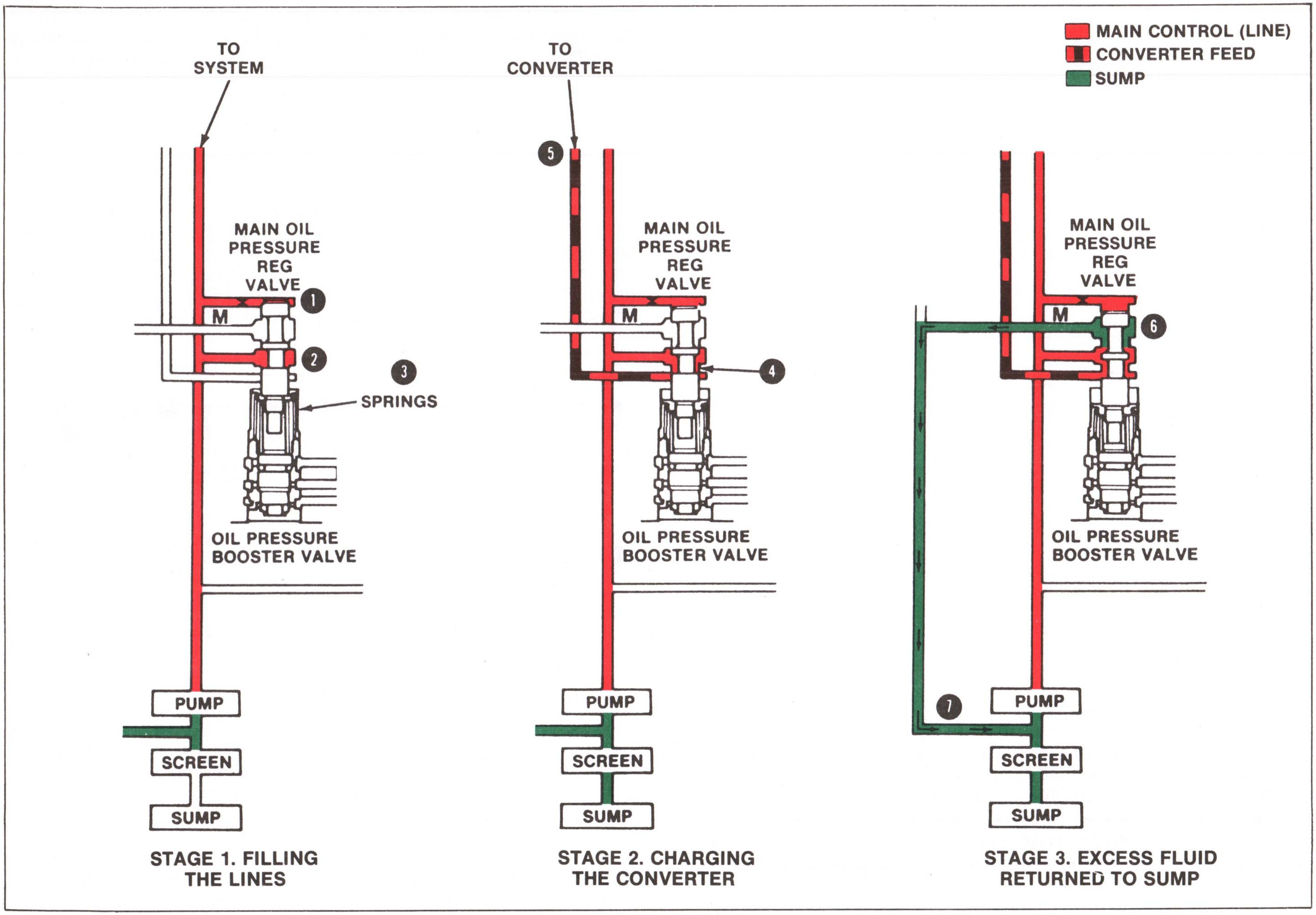
POSITIVE DISPLACEMENT

A pump that has the outlet sealed from the inlet like this is called a **positive displacement** or positive delivery pump. This means that as long as the pump is turning and fluid is supplied to the inlet, the pump will deliver fluid — the volume being in proportion to the drive speed. The pump is designed to deliver more fluid than the transmission needs, and excess pump delivery is recirculated to sump by the pressure regulator valve.

A NOTE ABOUT "FLUID" (HYDRAULIC OIL)

The oil or fluid used in all automatic transmissions is special. Automatic transmission fluid is composed of mineral oil and additives. In the transmission, it is used as a combination power-transmission medium, hydraulic control fluid, heat transfer medium, bearing-surface lubricant, and gear lubricant. In all cases, the manufacturer's recommendations should be followed when servicing the transmission fluid. The oil dipstick is stamped with the type fluid required for the transmission.

THE MAIN OIL PRESSURE REGULATOR VALVE



STAGE 1. FILLING THE LINES

STAGE 2. CHARGING THE CONVERTER

STAGE 3. EXCESS FLUID RETURNED TO SUMP

Figure 39 — Pressure Regulator Valve Operating Stages

As shown in Figure 39, the pump output is directed to two passages at the main oil pressure regulator valve.

❶ The passage at the inner end of the valve is the control passage. When pressure builds up here, it will tend to move the valve outward against spring force.

❷ The center passage is the source for torque converter feed and the path for excess pump flow.

NOTE: As we describe valve operation, we'll use the term "in" or "inward" to refer to a position toward the center of the valve body. Conversely, "out" or "outward" will denote away from the valve body center.

STAGE 1. FILLING THE LINES

We can consider the pressure regulator valve to have three stages of operation (Figure 39). In stage 1, while the lines are being filled, there is little resistance to flow in the system, so pressure doesn't build-up. In this stage, the springs ❸ hold the regulator valve in the in or closed position.

NOTE: As you go through this section, it will be easy to understand that though all the lines are not always under pressure, they are kept full of fluid at all times. So when a valve is shifted, the transmission responds immediately. Because of this, the system usually needs only enough fluid from the pump to make up for internal leakage. So the first stage of regulation occurs immediately when the pump begins to rotate.

STAGE 2. CONVERTER SUPPLY

As pressure begins to rise, the regulator valve is forced out against the springs, and another port is uncovered ❹. Now, fluid from the pump can flow into the converter circuit, and the converter will become pressurized ❺ or "charged".

The converter also is kept filled all the time, so this second stage, too, happens immediately. When the converter is pressurized, we again need a path for the pump delivery if we want to prevent pressure from building excessively.

STAGE 3. EXCESS RETURNED TO PUMP INLET

So now we come to the third stage of regulation, which is the usual condition when the engine is operating. The regulator valve is forced farther out against the springs and opens another passage ❻. All pump delivery not needed by the system or converter is now returned to the pump inlet ❼.

"BALANCED" VALVE OPERATION

The pressure in the main control pressure system now is being regulated by balancing the pressure in passage ❶ against the force of the valve springs ❸. In other words, the springs control the pressure, and the valve adjusts itself automatically so that the spring forces acting inward are equal to the hydraulic pressure force acting outward. If the pressure tries to drop, the springs will move the valve in and cut off part of the flow to sump, and even to the converter circuit if necessary to maintain the regulated pressure. Conversely, if the pressure tries to rise, the valve moves out and bypasses more oil to reduce the regulated pressure. We call the pressure regulator valve a balanced valve and we call the pressure it regulates control pressure or "line" pressure.

Further on, we will see how the oil pressure booster valve is used in various operating conditions to "add to" the spring force and increase the regulated control pressure.

TORQUE CONVERTER AND COOLER FLUID

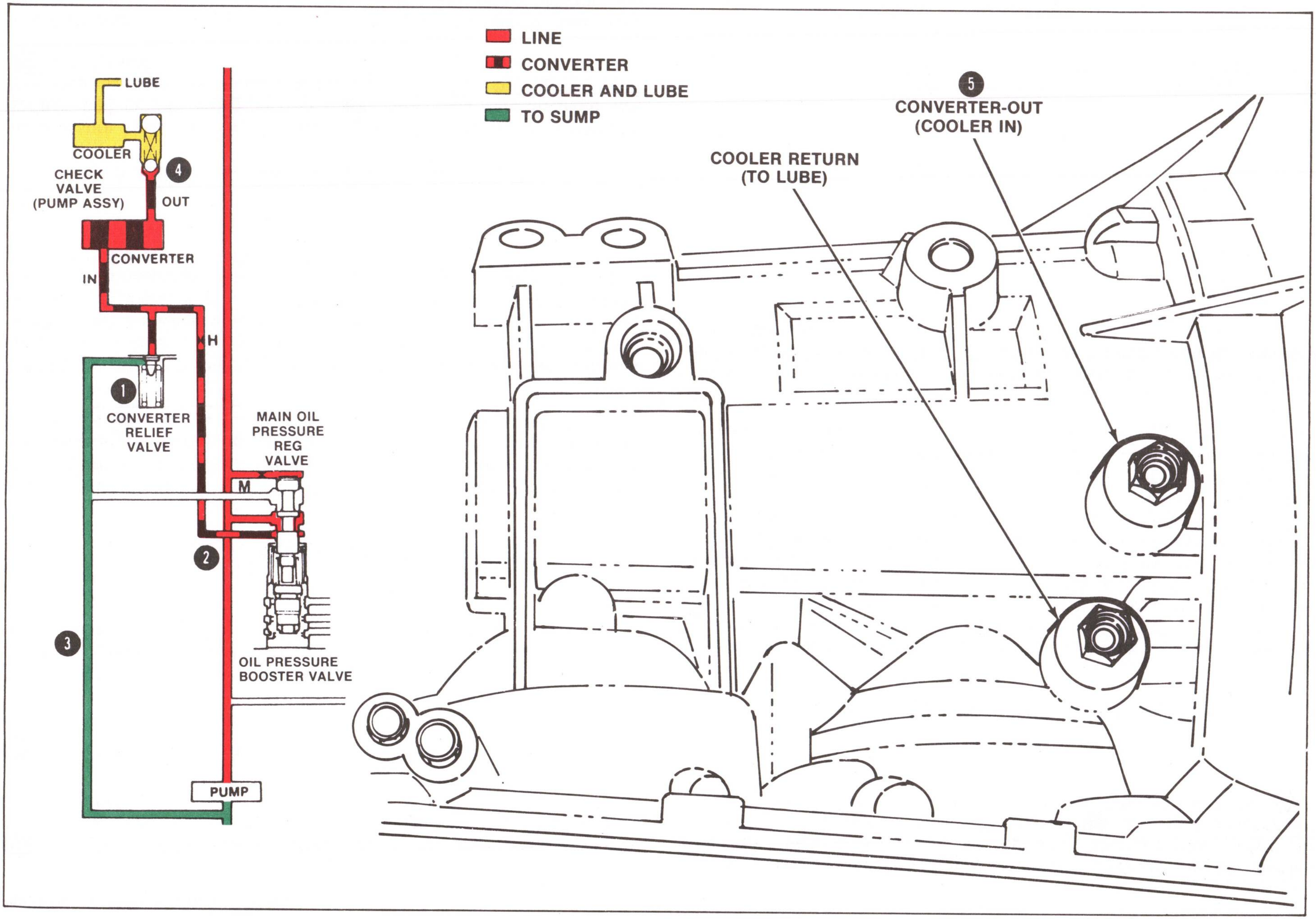


Figure 40 — Converter and Cooler Hydraulic Sub-System

The flow paths for torque converter and cooler-lube fluid were described earlier. It remains here only to discuss the converter circuit valving and identify the cooler line ports (Figure 40).

CONVERTER RELIEF VALVE

The converter relief valve ❶ is part of the main valve body assembly. Its purpose is simply to protect the converter from excessive pressure build-up.

High control pressure ❷ could subject the converter to pressures high enough to cause damage. The converter pressure relief valve is set to open at about 125 PSI. It will direct fluid back to the pump ❸ inlet if necessary to protect the converter.

CHECK VALVE

Leaving the converter, the fluid passes through a check valve ❹ on the way to the converter out port in the case ❺. The check valve has a very light spring and opens with low pressure for continuous fluid flow through the cooler. When the engine is shut down, the spring will seat the valve. This prevents the converter oil from draining through the cooler and lube system back to sump. Thus, the converter remains ''primed'' or full of fluid; and it can begin to transmit torque through the turbine (tube) shaft as soon as the engine is started.

''SERIES'' COOLING CIRCUIT

Experienced technicians will recognize that this circuit is different from several other automatics. It is called a ''series'' cooling circuit, since **all** the converter fluid goes to the cooler before it goes to the lube circuits. Other transmissions have the front lube circuit, and sometimes the rear lube as well, ''branched off'' ahead of the cooler.

MAIN CONTROL PRESSURE SYSTEM

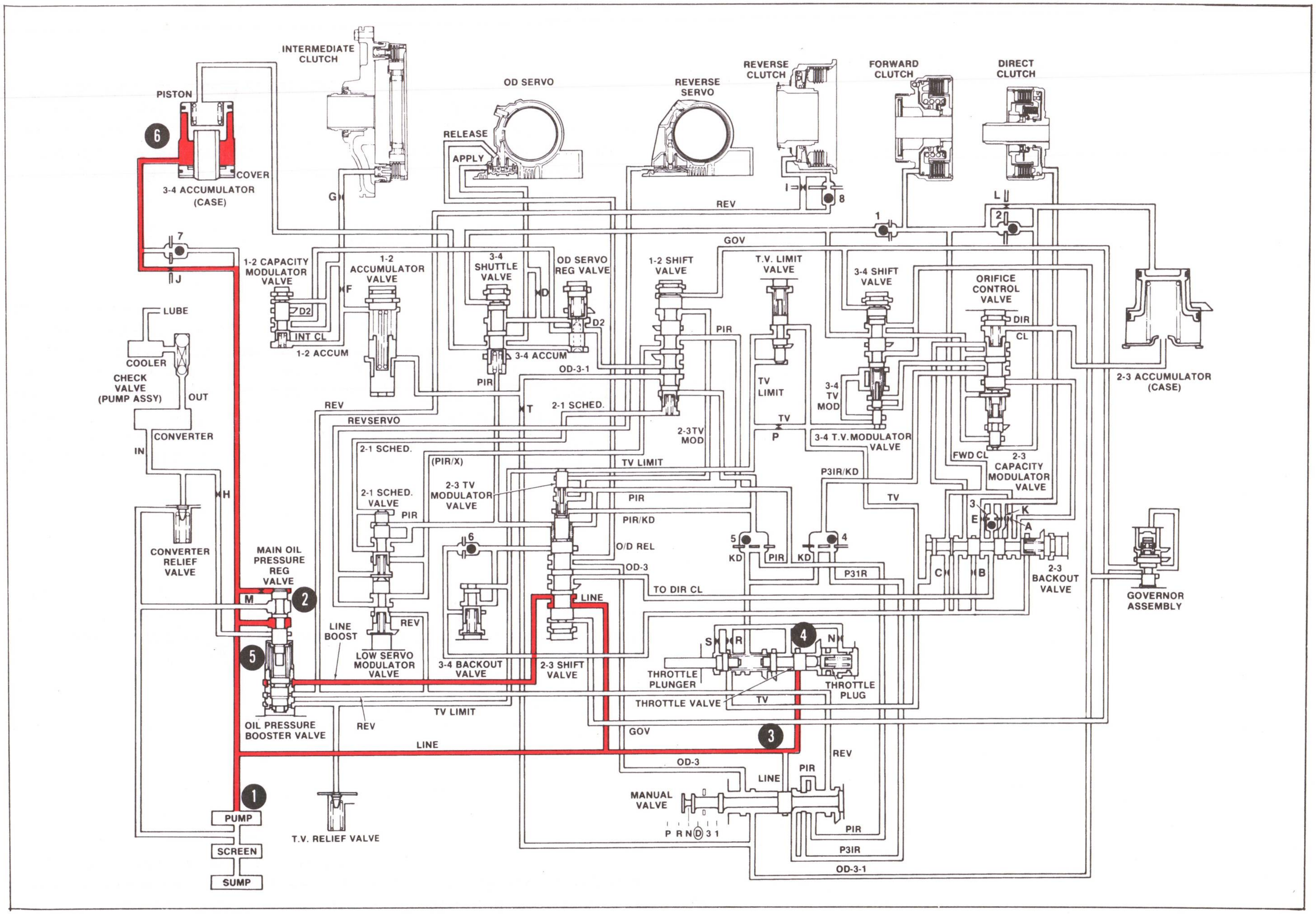


Figure 41 — Main Control Pressure System

NOTE: Until now, we have avoided mentioning any particular valves until we're ready to discuss them. But now as we go on to see how the valve system controls the gear train operation, we find that many valves are so closely interrelated that some valves must be mentioned before it's time to see how they operate. Don't let this bother you. Concentrate on the valve being discussed. The others will come up later, and they'll all be tied together before we're finished.

MAIN CONTROL PRESSURE SYSTEM

The main control pressure system is the part of the hydraulic control that is charged with pressurized fluid from the pump whenever the engine is running, regardless of the selector lever position. (In Figure 41, this system is shown in the neutral position.)

❶ The pressure fluid source, as described earlier is the oil pump.

❷ The main oil pressure regulator valve determines how high the main control pressure will be. We have so far described only the effect of its spring in determining control pressure. Other pressures acting on it will be described further along.

❸ Control pressure is always available at the manual valve. In neutral, as shown, it is blocked by a valve land.

❹ Control pressure is directed to the throttle valve to supply the throttle pressure system.

❺ Control pressure is supplied through the 2-3 shift valve, to the oil pressure booster valve. (It is blocked from this valve by the 2-3 shift valve in third gear and overdrive.)

❻ Control pressure also acts "under" the 3-4 accumulator piston.

To get control pressure to any of the other components of the system for control of the gear train it is necessary to shift the manual valve.

MANUAL VALVE AND CONTROL PASSAGES

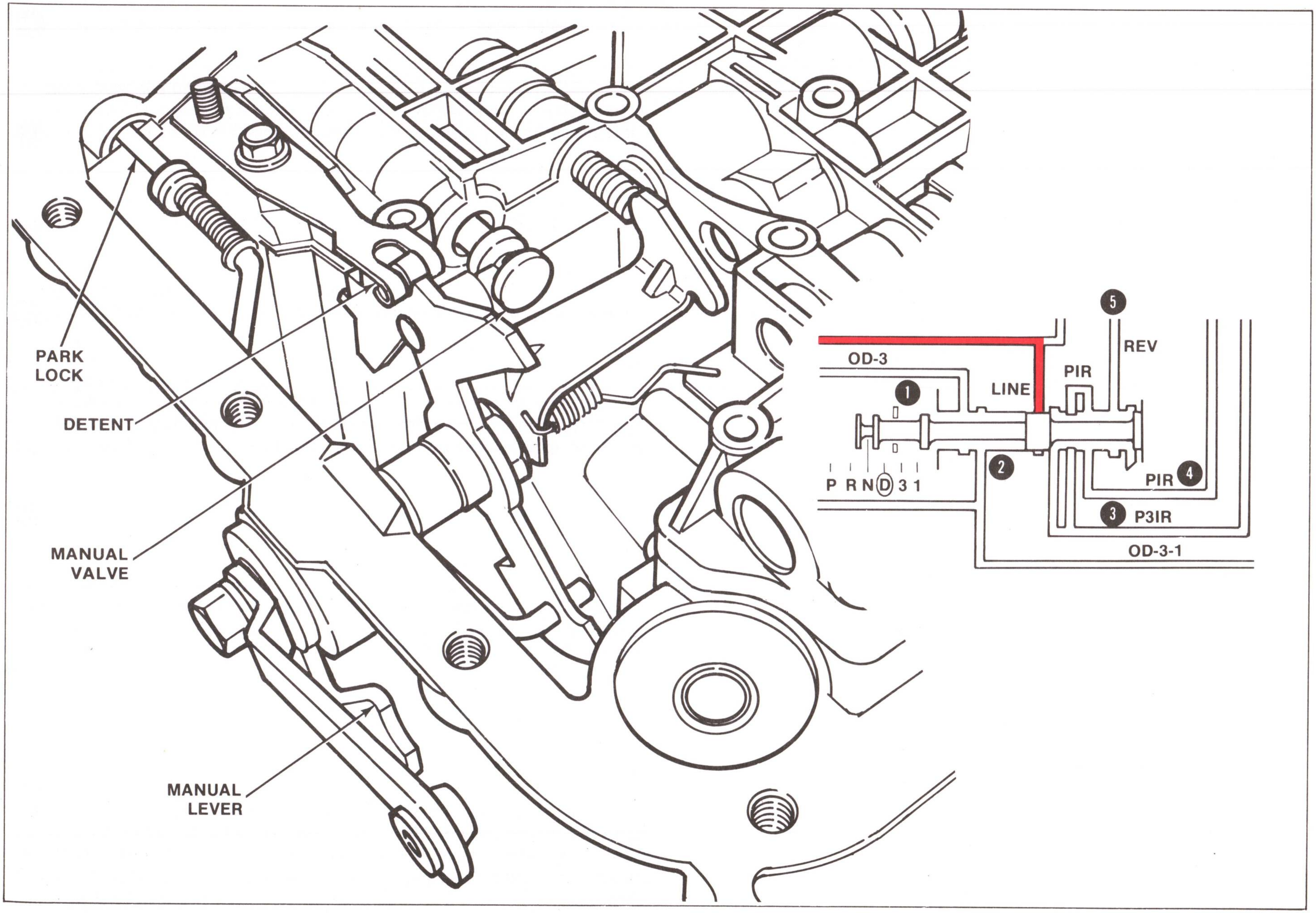


Figure 42 — Manual Valve and Controlling Passages

The transmission manual control valve (Figure 42) is on-off valve. Its function is to direct control pressure to certain systems to apply the holding members which are involved in starting out in each range, and also to furnish control pressure to the valves involved in automatic shifting in each range.

A mechanical linkage from the shift selector controls the manual valve position through the manual valve lever. The valve is held or ''detented'' in each position by a detent lever and spring-loaded roller.

Let's see now just how the gear train is ''controlled'' in the various positions of the manual valve.

MANUAL VALVE PASSAGES

As shown in Figure 42, there are five pressure passages leading from the manual valve in addition to the line pressure passage to the valve. Here's how those passages are identified with a brief description of what each does.

❶ **OD-3 PASSAGE** — Charged when the manual valve is in Ⓓ range or in 3 range. This passage supplies release pressure to the overdrive servo in the first and second gear. In third and overdrive, it supplies apply pressure for the direct clutch.

❷ **OD-3-1 PASSAGE** — Charged in any forward range. Routes pressure to the 3-4 shift valve to supply the forward clutch, and supplies the Governor System (see next page). Also routes line pressure to the 1-2 shift valve and 1-2 accumulator valve to prepare for upshift to second gear.

❸ **P-3-1-R PASSAGE** — Charged in all positions except Neutral and Ⓓ (overdrive). Supplies the orifice control valve and the 3-4 T.V. modulator valve to block out 4th gear operation.

❹ **P-1-R PASSAGE** — Charged in Park, Reverse and manual Low. Locks out the 1-2 upshift in manual low by applying line pressure to the 1-2 shift valve. Holds the 2-3 shift valve and 3-4 shuttle valve outward. Supplies oil to the 2-1 scheduling valve.

❺ **REV PASSAGE** — Charged in Reverse only. Provides apply pressure for the reverse clutch. Holds the low servo modulator valve outward and applies the reverse servo. Also pressurizes the booster valve to increase line pressure in Reverse gear.

It should be noted that these passages are pressurized only in the ranges described. In all other ranges, they are ''exhausted'' or vented to sump.

In the following pages now, we will describe the sub-systems that are charged by these passages. The illustrations will be color coded only in the passages that apply to the descriptions.

(Full system schematics for various operating conditions are in the next section.)

FORWARD CLUTCH AND GOVERNOR SYSTEM

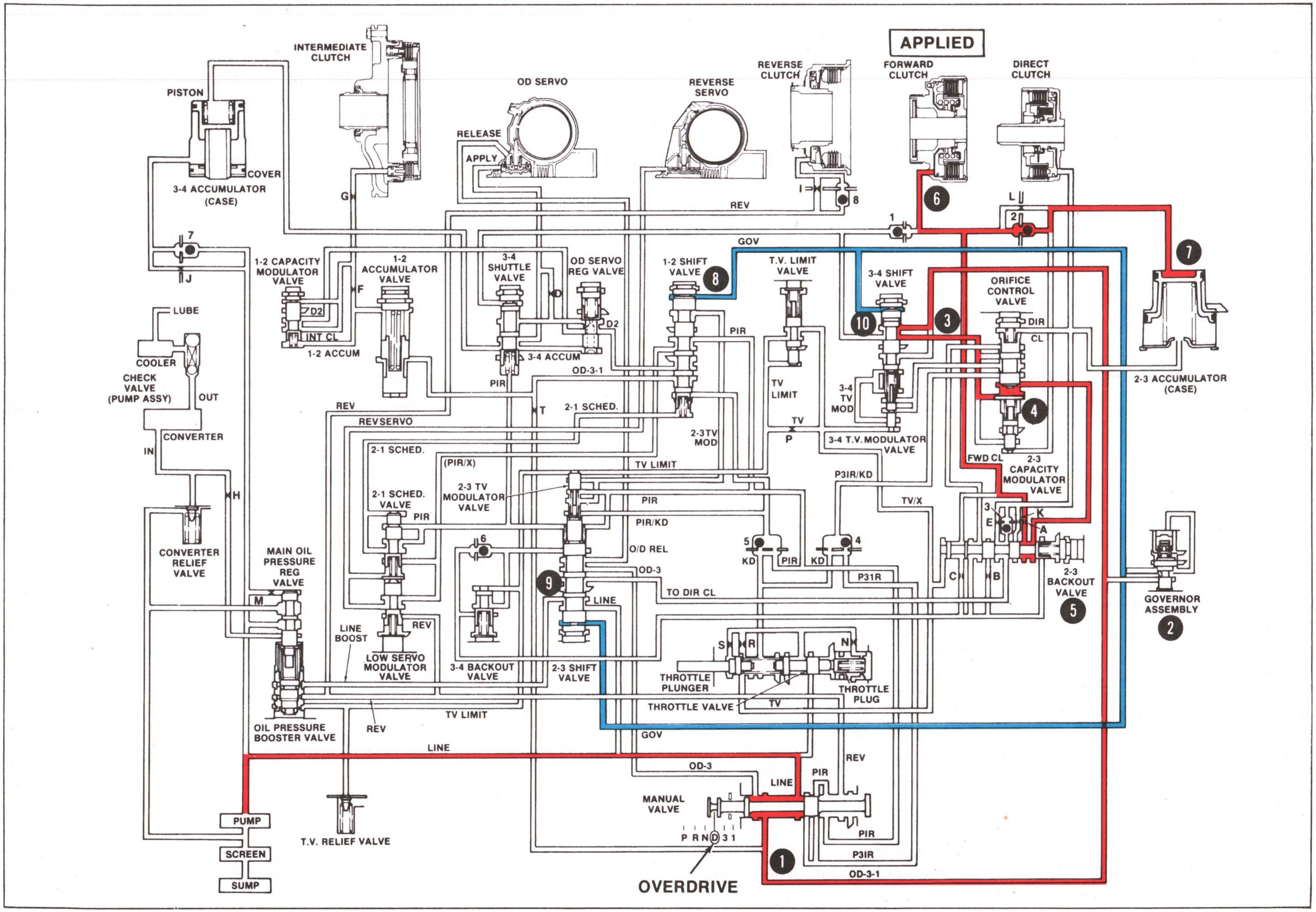


Figure 43 — Forward Clutch and Governor System at Initial Engagement

FORWARD CLUTCH APPLY SYSTEM

There are several different ways to apply the forward clutch, depending on speed, throttle opening and gear ratio. In this illustration (Figure 43), we are showing **initial engagement.** The car is stopped, the throttle is closed, and the driver chooses the overdrive range.

❶ The OD-3-1 passage is charged at the manual valve with line pressure from the Main Pressure Regulator System.

❷ Line pressure is applied to the governor-in passage, through the output shaft. (As with all other Ford automatics, the governor is supplied in all forward ranges.)

❸ Pressure continues to and through the 3-4 shift valve to the inner end of the orifice control valve.

❹ Pressure overcomes the orifice control valve spring and moves the valve outward. This opens a passage to the 2-3 backout valve.

❺ The 2-3 backout valve is positioned inward at closed throttle by its spring's force. Pressure flows through orifice A; and into the FWD CL passage.

❻ Pressure in FWD CL passage applies the forward clutch.

❼ Forward clutch apply pressure also acts above the 2-3 accumulator piston. The piston moves downward against spring force to control the apply pressure for a smooth engagement.

GOVERNOR PRESSURE

Experienced Ford technicians will recognize that the governor (Figure 44) is similar to the governor in the FMX transmission. The assembly is keyed to and turns with the output shaft. The design is such that governor pressure output rises sharply at low RPM and then less sharply at higher RPM.

Governor pressure (Figure 43) is applied to the outer ends of:

❽ 1-2 shift valve,

❾ 2-3 shift valve, and

❿ 3-4 shift valve.

At each shift valve, governor pressure will be opposed by spring force and by pressures on the valve. As governor pressure increases, it will force each of the shift valves, in turn, to the inward position to cause an upshift.

LOW GEAR START IN Ⓓ OR 3

We have just seen that the forward clutch is applied through the manual valve OD-3-1 passage. Since the other holding member in an overdrive or 3 range start-up is the low (planetary) one-way clutch, we already have the ingredients for a low gear start in these ranges.

Remember now, that for **manual** low (1 range) we have to apply a band so that when the vehicle is coasting engine braking occurs. Let's cover that next.

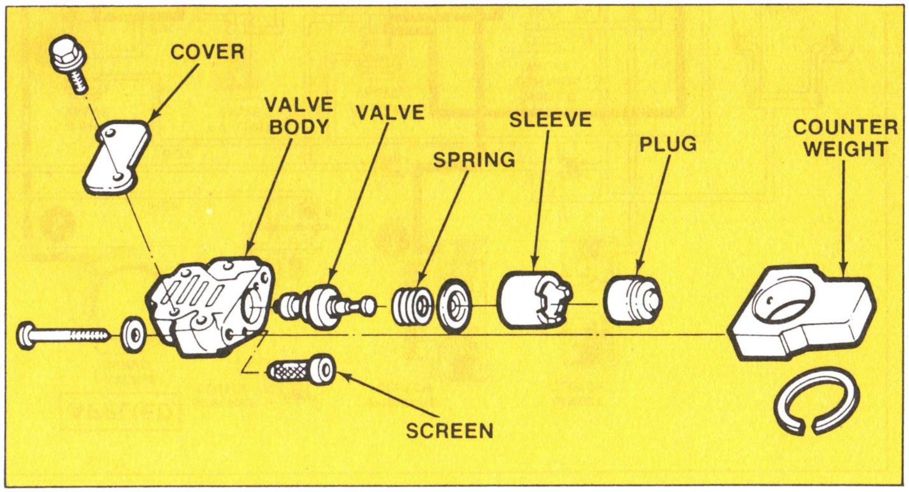


Figure 44 — Governor Assembly

MODULATED LOW-REVERSE SERVO APPLY PRESSURE

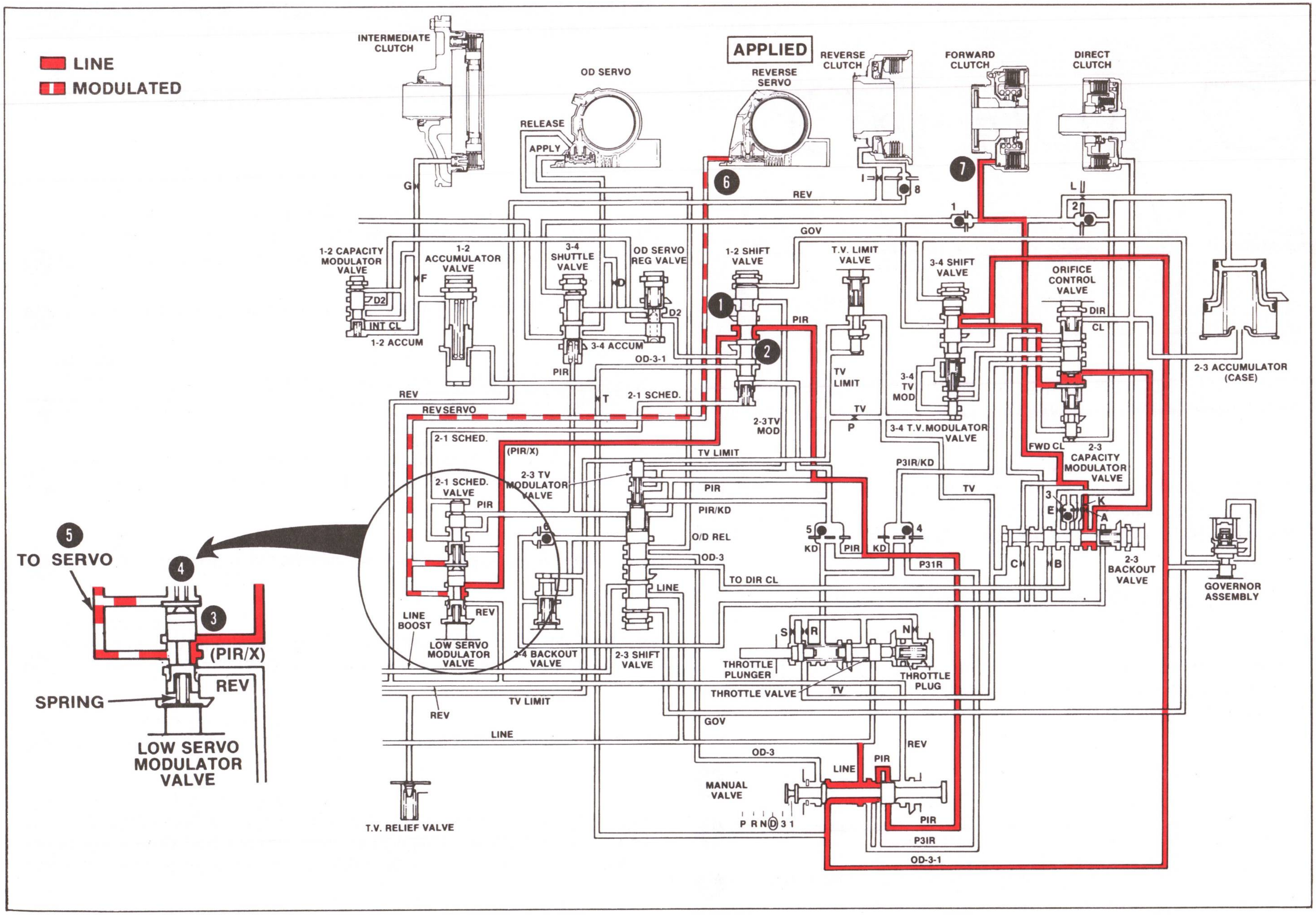


Figure 45 — Modulated Servo Apply Pressure and Manual Low Start

LOW SERVO MODULATOR VALVE

We have said earlier that the purpose of the low servo modulator valve is to regulate the apply pressure on the servo piston in 1st gear of manual low range. Regulating this pressure to less than line pressure makes for a smoother 2-1 downshift in 1 range.

The regulation of reverse servo pressure (see Figure 45) actually occurs in Park range as well, due to the routing of pressure from the manual valve.

MODULATED APPLY PRESSURE

Here is how the pressure modulation occurs:

❶ The 1-2 shift valve is in its out or downshifted position.

❷ P-1-R pressure from the manual valve is directed through the 1-2 shift valve to the low servo modulator valve.

❸ This pressure first goes through the space between the modulator valve lands; then to the inner (top of picture) end of the valve.

❹ Pressure at the valve inner end opposes the valve spring and moves the valve outward. This partially closes off the line pressure passage at ❸ and the valve begins to regulate.

❺ A reduced or modulated pressure thus is applied to the servo piston.

MANUAL LOW START

Now, as shown in Figure 45, the necessary holding members are applied for manual low 1st gear.

❻ The low-and-reverse servo is applied by modulated pressure from the low servo modulator valve. With the band applied, the one way clutch will not overrun and engine braking is available.

❼ The forward clutch is applied from the OD-3-1 passage (Figure 43).

We have said that there is no 1-2 upshift in manual low range. Thus, it is necessary to have a Second Gear Lockout in selector position 1. Let's describe that next.

SECOND GEAR LOCKOUT IN MANUAL LOW

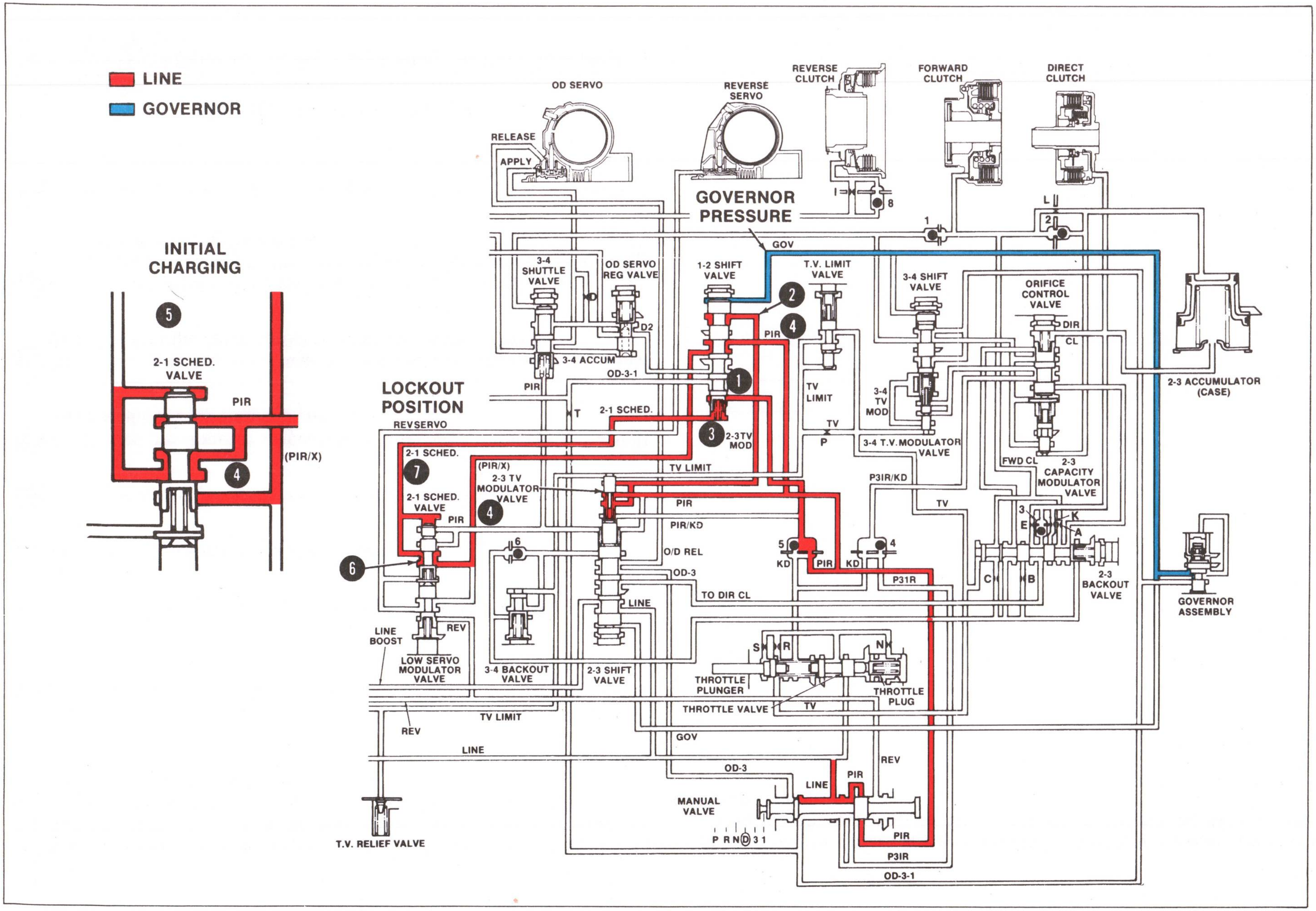


Figure 46 — Second Gear Lockout in Manual Low

LOCKOUT PRESSURES

Second gear lockout in manual low is accomplished by applying line pressure (Figure 46) to the 1-2 shift valve to hold it outward against governor pressure.

❶ Pressure from the P-1-R passage is effective on a differential area of the valve. (This area is also used in "kickdown" shifting as will be described later.)

❷ Pressure at the top differential area of the valve from the 2-3 throttle modulator valve.

❸ Pressure at the spring end of the valve from the 2-1 scheduling valve. These pressures, added to spring force, will always be enough to offset governor pressure.

LOCKOUT PRESSURE FROM 2-1 SCHEDULING VALVE

Here is how the lockout pressure gets to the shift valve from the 2-1 scheduling valve.

❹ During initial charging, P-1-R pressure is routed to the space between the 2-1 scheduling valve lands (left view of Figure 47).

❺ This same pressure is effective at the inner (top) end of the valve and moves it outward.

❻ With the valve out (lockout position in the right view) P-1-R-X pressure from the 1-2 shift valve is effective between the scheduling valve lands.

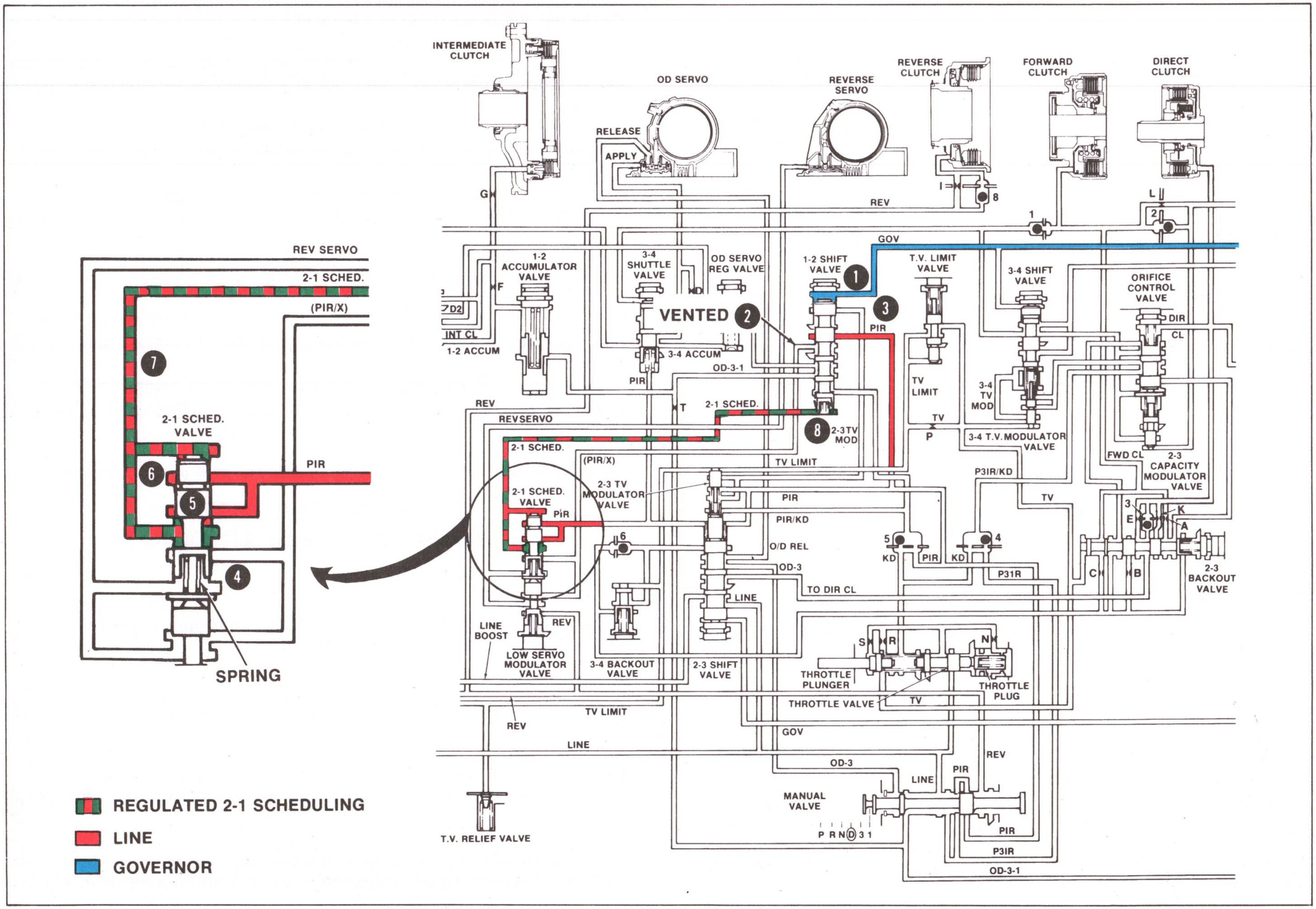
❼ This pressure is then transmitted through the 2-1 SCHED passage to the lockout passage ❷ at the end of the 1-2 shift valve.

Line pressure now acts on all the outward areas of the 1-2 shift valve and insures that the valve stays outward in 1st gear position.

The 2-1 scheduling valve operates in the "out" (lockout) position as described in Park and in manual Low 1st gear.

(In all other selector ranges, it is in the normal or inward position and has no effect on shifts or engagement.) But in second gear in manual low range it operates as a pressure regulator. That operation is described on the next page.

2-1 SCHEDULING VALVE PRESSURE REGULATION



🟩 REGULATED 2-1 SCHEDULING

🟥 LINE

🟦 GOVERNOR

Figure 47 — Regulated 2-1 Scheduling Pressure to the 1-2 Shift Valve

TIMING THE 2-1 DOWNSHIFT

When the shift selector is moved to manual low from either overdrive or direct range, the transmission first shifts down into second gear. (This presumes that the vehicle is at a cruising speed in third or fourth gear.) As speed decreases, it will downshift to first gear. The 2-1 scheduling valve (Figure 47) regulates a pressure under the 1-2 shift valve to move it outward at the pre-determined speed.

REGULATED 2-1 SCHEDULING PRESSURE

Let's describe how and why this can be:

① We start with the 1-2 shift valve in the in or upshifted position (where it will always be in second, third, or fourth gear). Governor pressure is holding it in against spring force.

② The P-1-R-X passage is vented when the valve is inward, and,

③ P-1-R pressure is blocked at the valve.

④ Thus, there is no line pressure available to the P-1-R-X passage at the 2-1 scheduling valve. And so the valve cannot transmit line (lockout) pressure to the shift valve **until after the 2-1 shift occurs.**

⑤ Instead, the valve moves only partly in from pressure opposing the spring and operates as a pressure regulator. There are two pressures balanced against the spring.

⑥ P-1-R line pressure operates on a differential area of the valve. This pressure will vary with throttle opening, so that the regulated pressure also will vary with throttle opening. (See Throttle Valve System later in this booklet.)

⑦ Regulated 2-1 scheduling pressure also opposes spring force. This is the pressure that is applied to the 1-2 shift valve.

2-1 DOWNSHIFT IN 1 RANGE

⑧ When the regulated pressure on the shift valve (plus its spring) overcomes governor pressure, the shift valve will move out and the 2-1 downshift will occur.

The manual low gear systems then, will take over as described on the preceding pages:

FIGURE 45 — The low servo modulator valve will produce modulated pressure to apply the servo.

FIGURE 46 — The 2-1 scheduling valve will change from "regulating" to lockout operation so that the transmission cannot upshift.

REVERSE GEAR SYSTEMS

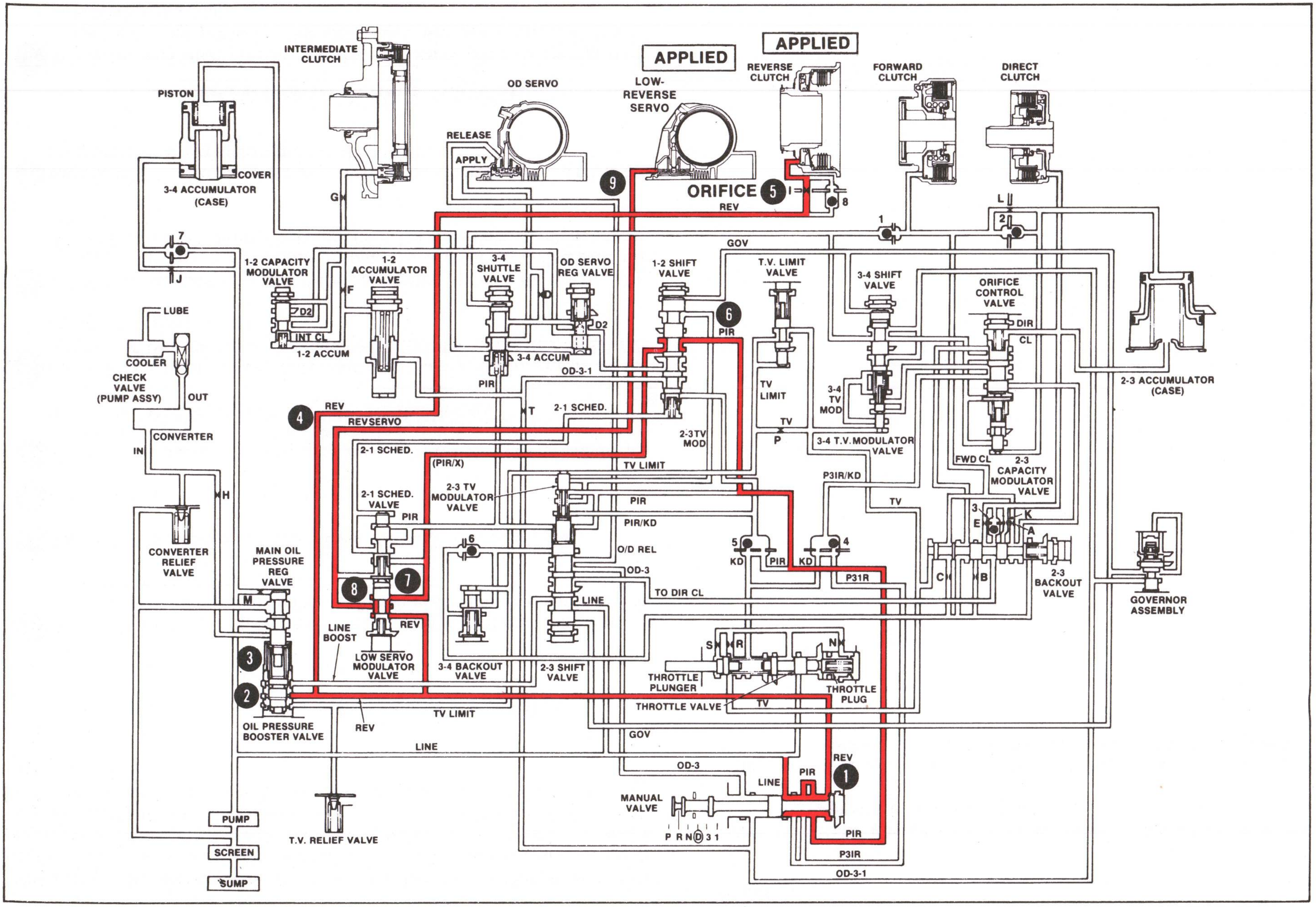


Figure 48 — Applying the Reverse Servo and Reverse Clutch in "R" Range

All the sub-systems required to engage the transmission in reverse are charged from the REV passage of the manual valve (Figure 48). Once again, remember we are not showing a full schematic of reverse operation yet. That is in the next section. So ignore any parts of the schematic not involved in the descriptions that follow.

REVERSE PRESSURE BOOST

❶ The REV passage is charged with line pressure at the manual valve.

❷ Line pressure from the REV passage is applied to a differential area of the oil pressure booster valve.

❸ This forces the valve inward (up in the picture), overcomes the booster (inner) spring, and the booster valve contacts the main regulator valve. This causes the main regulator valve to regulate at a higher line pressure.

Higher line pressure is required in reverse to give sufficient holding ability to the reverse band and reverse clutch so that the transmission can handle higher torque without the band or clutch slipping.

REVERSE CLUTCH APPLY

❹ Another branch of the REV passage goes through the pump assembly and stator support to the reverse clutch.

❺ The reverse clutch is applied by pressure behind the piston. An orifice delays the application slightly for smooth engagement.

REVERSE SERVO APPLY

❻ The P-1-R passage is charged from the manual valve; and in turn charges the P-R/X passage at the 1-2 shift valve.

❼ The P-R/X passage is effective on a differential area between the lands of the low servo modulator valve. With high line pressure, enough force is available to move the valve out against its spring force.

❽ The low servo modulator valve now opens both the REV and the P-R/X passages to the REV SERVO passage. Since both sources are at boosted line pressure . . .

❾ The low-reverse servo is applied with full boosted line pressure (rather than a modulated pressure as in low gear).

THROTTLE VALVE (T.V.) OPERATION

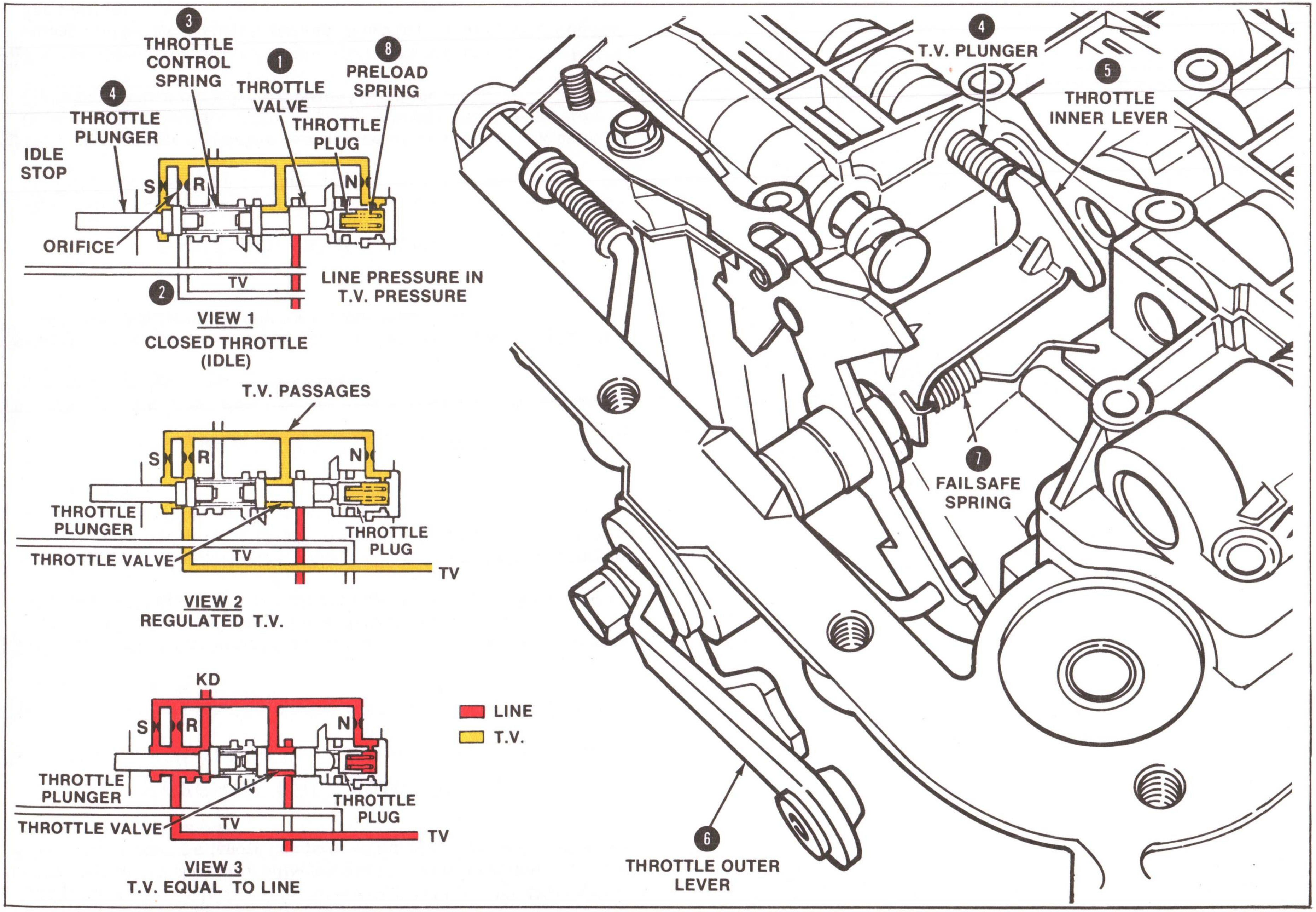


Figure 49 — Throttle Valve Operation

The throttle valve or "T.V." (Figure 49) is used to provide an engine-load pressure signal to the transmission hydraulic system. The primary purposes of T.V. pressure are to (1) boost line pressure when the transmission has to handle high torque, and (2) to act on the shift valves to delay upshifts or force downshifts when engine load demands it.

MECHANICAL OPERATION

The throttle valve is a balanced pressure-regulating valve, with the T.V. pressure ② output determined by the force of the T.V. spring ③. On the automatic overdrive transmission, the spring is compressed by the T.V. plunger ④. The plunger is activated by the inner throttle lever ⑤, through a shaft which is turned by the outer throttle lever ⑥. This lever is linked to the carburetor throttle linkage. Thus, the further the accelerator pedal is depressed, the farther the plunger is pushed in to compress the T.V. spring ③.

The plunger is "power assisted" with T.V. pressure to reduce the effort required to move it, and the diameters of the plunger and throttle plug are chosen to provide a uniform actuation force. The preload spring determines the actuation force.

A torsion spring ⑦ loads the inner T.V. ⑤ lever toward wide-open throttle. If the linkage from the carburetor should become disconnected, the torsion spring, with the engine running, will move the plunger to wide-open throttle to give maximum T.V. pressure and therefore maximum line pressure. The maximum pressure is required to prevent the clutches and bands from slipping or burning up if the engine is operated at heavy throttle.

HYDRAULIC OPERATION

VIEW 1 — CLOSED THROTTLE — ZERO T.V.

At closed throttle (idle) the plunger is positioned outward (toward the left) as shown in View 1 of Figure 49. The inner T.V. lever ⑤ rests against the idle stop to provide an accurate closed throttle position for the plunger. The idle stop is a recess cast into the valve body.

T.V. spring force, even at closed throttle, is sufficient to overcome the preload spring force ⑧. The throttle valve is moved toward the right, and regulates a pressure by balancing the net spring load against the regulated pressure acting on the throttle plug. A small amount of oil "leaks" through orifice R, past the gap at the end of the plunger, and out to sump through the vent between the valves. The source of the T.V. pressure going to the rest of the valve body is located downstream from orifice R and at closed throttle this pressure is zero since it is being vented.

A small movement of the plunger away from closed throttle will close the gap at the end of the plunger and stop the "leak". T.V. pressure going to the rest of the body would then suddenly rise to the pressure being regulated by the throttle valve.

VIEW 2 — PART THROTTLE — REGULATED T.V.

The driver has depressed the accelerator pedal, which moves the plunger inward, further compressing the T.V. spring and increasing T.V. pressure. The gap has been closed and there is no more leak. T.V. pressure going to the rest of the system is being supplied through orifice R and orifice S.

VIEW 3 — WIDE OPEN THROTTLE — KICKDOWN

At full throttle, the throttle linkage positions the plunger as shown in View 3. The plunger contacts the throttle valve and moves it out of regulating position so that it opens up the line pressure passage and makes TV pressure equal to line pressure.

Notice that the plunger has pressurized the kickdown (KD) passage with line pressure. As we'll describe later the kickdown pressure acts on the shift valves to change the shifting speeds at wide open throttle.

THROTTLE PRESSURE (T.V.) SYSTEM OPERATION

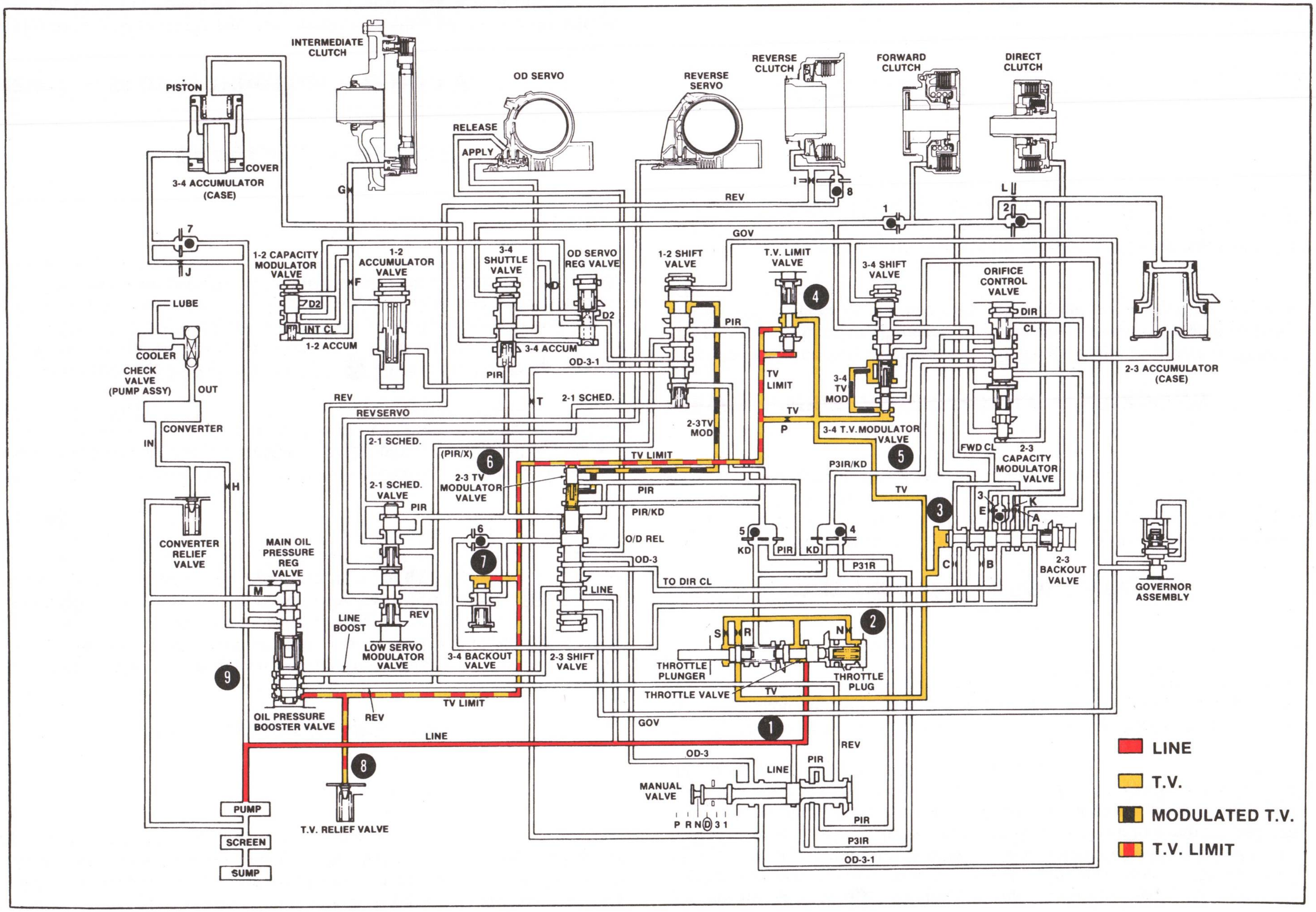


Figure 50 — Throttle Valve System

THROTTLE PRESSURE SYSTEM

Now we have a throttle valve (T.V.) pressure that increases as the throttle opening increases. This pressure, in its original or modified form, has several functions. Let's look at the overall system (Figure 50) and name the functions. Then we'll go into more detail as required.

T.V. PRESSURE

❶ Line pressure is supplied to the throttle valve whenever the engine is running, from the Main Pressure Control System.

❷ T.V. pressure is available in the T.V. passage as soon as the throttle is opened slightly.

❸ T.V. pressure is applied to the inner end of the 2-3 backout valve. This pressure will shift the 2-3 backout valve outward anytime the T.V. passage is charged.

❹ T.V. pressure is applied to the T.V. limit valve, which regulates at about 85 psi. If T.V. pressure is below 85 psi, it will continue into the TV LIMIT passages without regulation. If it is above 85 psi, the valve will maintain 85 psi in the TV LIMIT passages.

❺ T.V. pressure is also applied to the 3-4 T.V. modulator valve. This valve may produce a modulated T.V. pressure to control the 3-4 shift valve.

T.V. LIMIT PRESSURE

T.V. limit pressure is applied to:

❻ The 2-3 T.V. modulator valve. This valve may produce a modulated T.V. pressure to control the 2-3 shift valve and the 1-2 shift valve.

❼ The 3-4 backout valve. Like the 2-3 backout, this valve is shifted outward whenever there is T.V. pressure. (At closed throttle, when T.V. pressure is zero, the 3-4 backout valve regulates O.D. servo release pressure in 4th gear.)

❽ The T.V. relief valve which will relieve at about 125 psi if the T.V. limit valve is not regulating properly.

❾ The outer end of the oil pressure boost valve. This increases the force of the booster valve acting on the main pressure regulator valve; which, in turn, increases line pressure.

Thus, line pressure will be boosted in proportion to T.V. pressure **up to about 85 psi T.V.** Beyond that, there is no further T.V. boost to line pressure. (This is the principal reason for using a T.V. limit valve. If full T.V. pressure were available at the boost valve, it would cause excessively high line pressures and possible damage.)

UPSHIFT DELAY PRESSURES

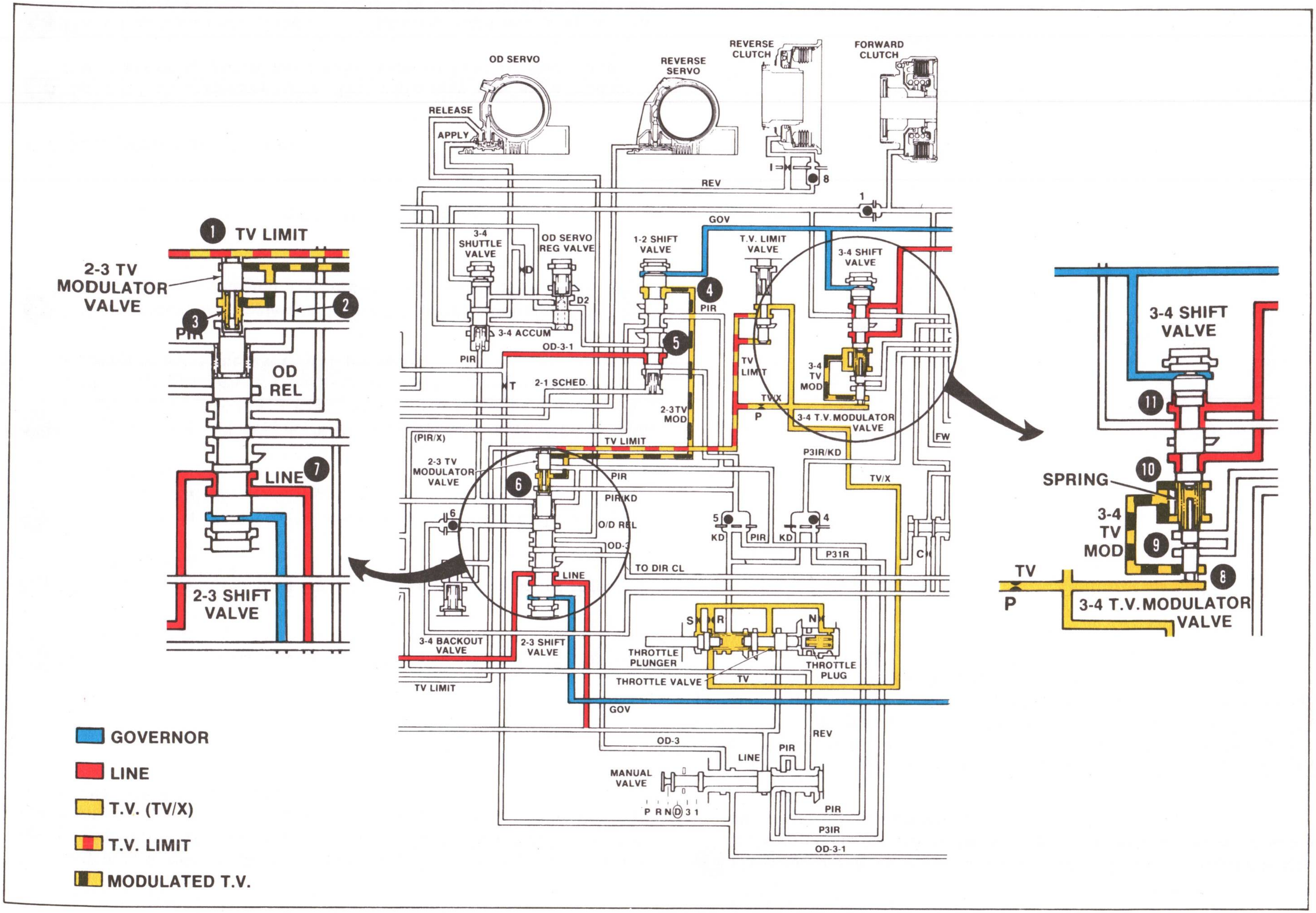


Figure 51 — Modulated T.V. Pressures and Other Upshift Delay Pressures

We have seen that the governor pressure acts on all the shift valves to move them to the in or upshifted position. Now it is time to summarize the forces and pressures that oppose governor pressure and tend to delay the upshifts.

2-3 T.V. MODULATOR PRESSURE

This pressure (Figure 51) is modulated at the 2-3 T.V. modulator valve as follows:

❶ T.V. limit pressure is applied to the inner (top) end of the valve and pushes it out against spring force when the pressure is high enough.

❷ The 2-3 TV MOD passage is now cracked open to T.V. limit pressure, and the valve begins to modulate.

❸ Modulated pressure assists the valve spring to oppose T.V. limit pressure. The modulated pressure is determined by T.V. limit pressure and the spring force.

1-2 SHIFT VALVE DELAY PRESSURES

Pressures on the 1-2 shift valve that oppose the governor are (Figure 51):

❹ 2-3 T.V. modulator pressure acting on a differential area between the two outer lands.

❺ Line pressure from the OD-3-1 passage acting on a differential area.

2-3 SHIFT VALVE DELAY PRESSURES

On the 2-3 shift valve, the pressures opposing the governor are:

❻ 2-3 T.V. modulator pressure acting directly against the inner end of the valve.

❼ Line pressure acting on a differential area between the two outer valve lands.

3-4 T.V. MODULATOR PRESSURE

This pressure is created similarly to 2-3 modulator pressure, except that the source is T.V. pressure (right view in Figure 51).

❽ When T.V. pressure is high enough to overcome the valve spring, it forces the valve outward. T.V. pressure is "cracked" to the 3-4 TV MOD passage.

❾ The valve now balances modulated pressure plus spring force against T.V. pressure. This balance determines how high the modulated pressure will be.

3-4 SHIFT VALVE DELAY PRESSURES

Delay pressures opposing the governor on the 3-4 shift valve are:

❿ 3-4 T.V. modulator pressure acting directly against the valve's inner end.

⓫ Line pressure from the OD-3-1 passage acting on **two** differential areas between the lands.

"KICKDOWN" PRESSURE

Additional pressure from the KD passage is effective against all the shift valves at wide open throttle. This is described on page 68.

CLOSED THROTTLE DELAY

At closed throttle, there will be no T.V. and therefore no T.V. modulator pressures. Also, at light throttle, there may not be enough T.V. or T.V. limit pressure to cause the modulator valves to modulate. In either case then, the only delay forces will be from line pressure on the differential areas; plus, of course, spring force. Thus upshifts can occur at minimum road speeds with the throttle closed or nearly closed.

UPSHIFT SUPPLY PRESSURES

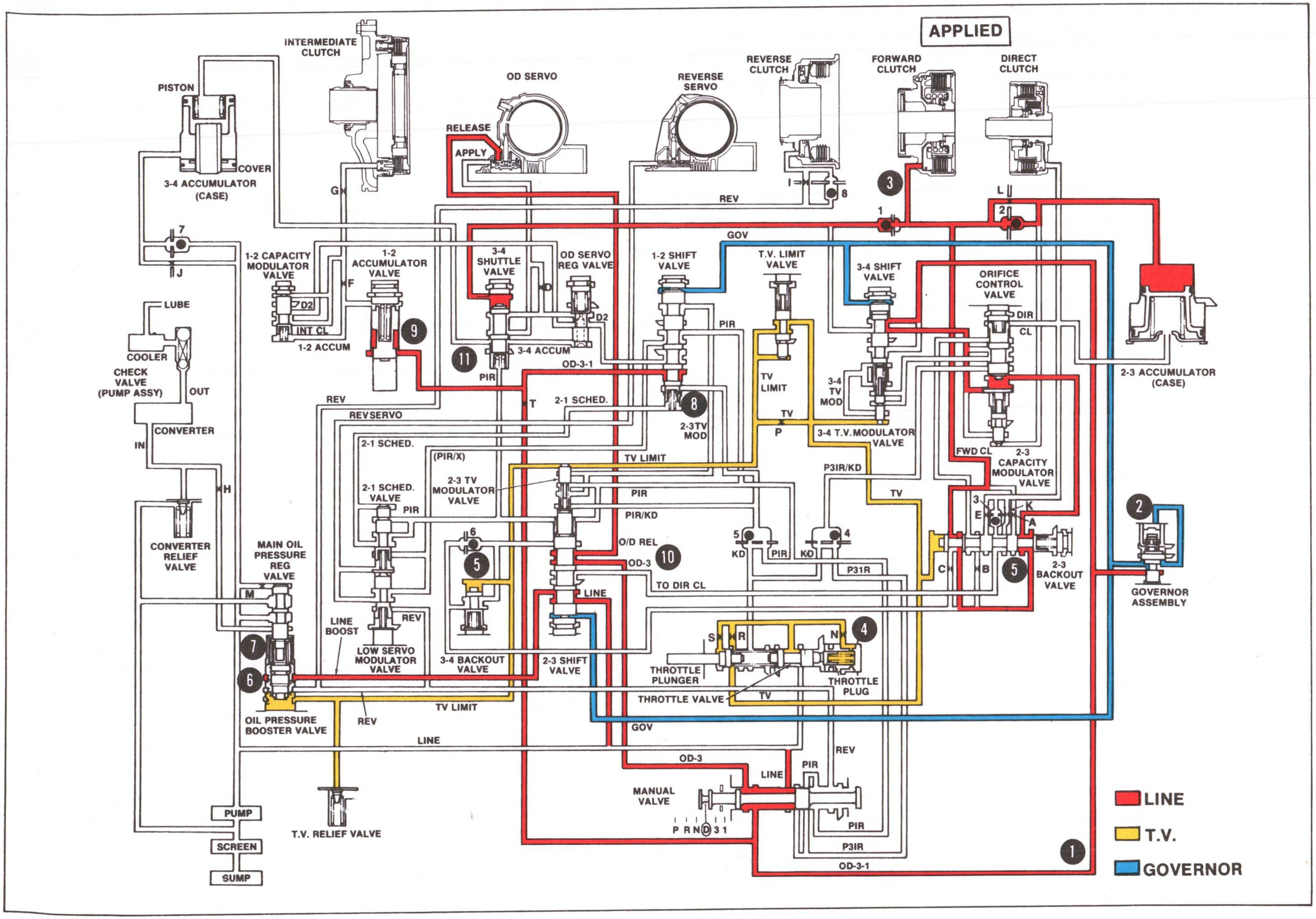


Figure 52 — Upshift Control and Supply Pressures in Overdrive Range — Shown in 1st Gear

Now that you are thoroughly familiar with the valves and systems that control automatic shifts, let's go back to the low gear situation and "set up" the conditions needed to allow the 1-2, 2-3 and 3-4 automatic upshifts.

Figure 52 illustrates as much of what is happening in the system in low gear at part throttle as is necessary to prepare for the upshifts.

❶ The forward clutch is applied and the governor system is charged through the OD-3-1 passage.

❷ The governor is putting out a low pressure signal, but all the shift valves are still in the outward or downshifted position.

❸ The forward clutch is applied through the 3-4 shift valve via the OD-3-1 passage.

❹ The throttle valve is producing T.V. pressure. (T.V. limit pressure and T.V. modulator pressures depend on throttle opening.)

❺ The backout valves are shifted outward by T.V. pressure.

BOOSTER PRESSURES

❻ T.V. pressure on the end of the oil pressure booster valve is causing line pressure to increase.

❼ Line pressure in the LINE BOOST passage is effective on a differential area of the pressure booster valve. This causes an additional pressure increase (until the 2-3 shift valve moves and cuts this passage off).

SHIFT SUPPLY PRESSURE

❽ Line pressure in the OD-3-1 passage is effective between two lands of the 1-2 shift valve. This pressure will supply the intermediate clutch on the 1-2 upshift.

❾ It is also effective between the lands of the 1-2 accumulator. This is a differential area, and the pressure holds the accumulator outward.

❿ The OD-3 passage supplies line pressure to the 2-3 shift valve for the 2-3 upshift.

3-4 SHUTTLE VALVE

⓫ The 3-4 shuttle valve is moved inward by forward clutch apply pressure. It remains inward through first, second and third gears. (It will move outward during the 3-4 shift.)

3-4 ACCUMULATOR

⓬ Line pressure is applied to the differential area of the 3-4 accumulator whenever the engine is running.

AUTOMATIC 1-2 UPSHIFT

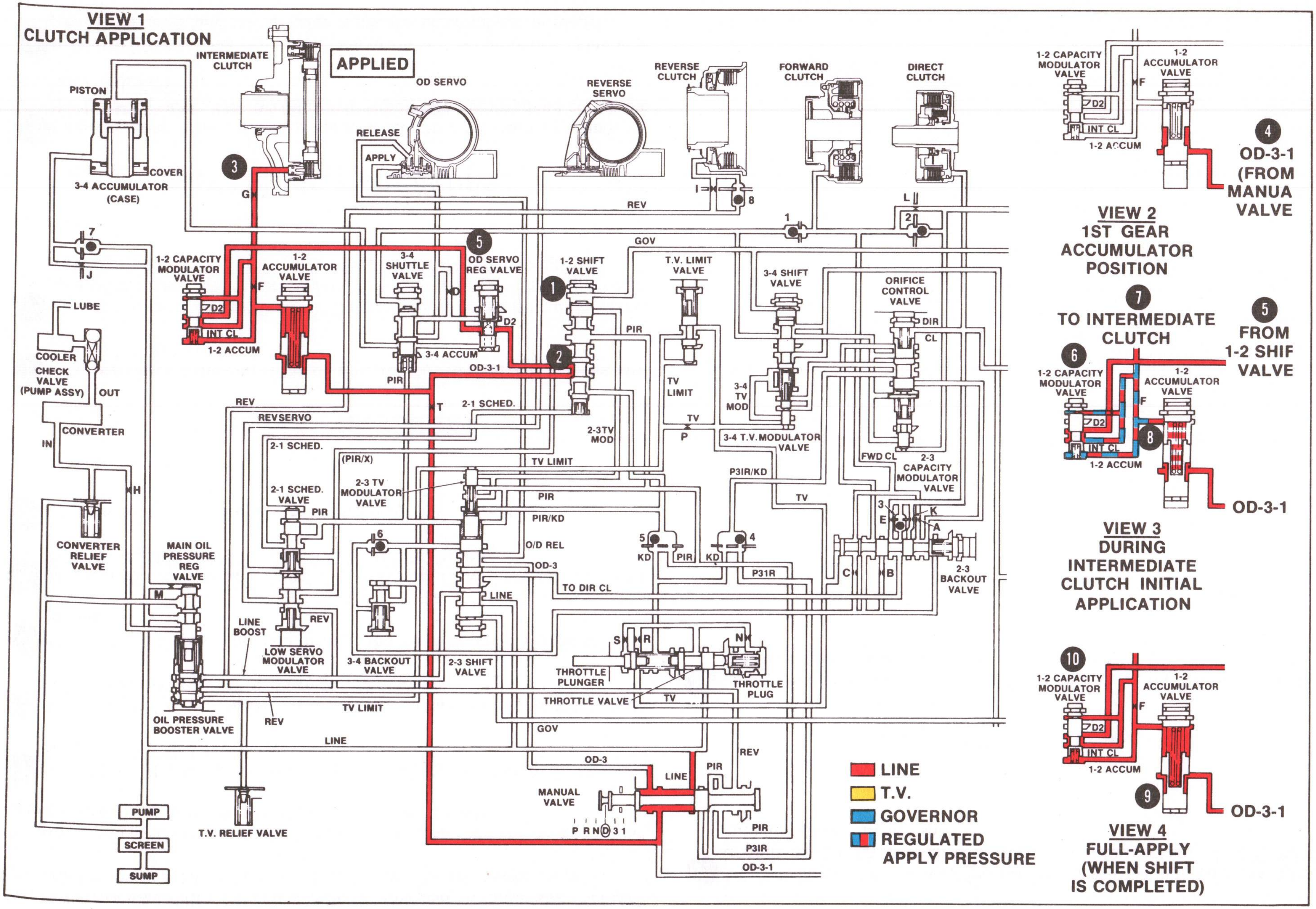


Figure 53 — Automatic 1-2 Upshift in Overdrive Range

INTERMEDIATE CLUTCH APPLICATION

The 1-2 automatic upshift consists simply of moving the 1-2 shift valve to get pressure behind the intermediate clutch piston. This phase of the shift is illustrated in View 1 of Figure 53.

① Governor pressure forces the 1-2 shift valve inward.

② The shift valve opens the OD-3-1 passage to the passages that apply the intermediate clutch.

③ The clutch is applied; with the 1-2 capacity modulator and the 1-2 accumulator cushioning the application.

CAPACITY MODULATOR AND ACCUMULATOR

The capacity modulator valve and the 1-2 accumulator are in the intermediate clutch apply system to cushion the upshift. This is done by controlling the rate at which the clutch applies, as shown in Views 2, 3 and 4 of Figure 53.

View 2. Before Application

④ Before the 1-2 shift valve moves, control pressure is effective only on the differential area of the accumulator. This is a direct connection from the manual valve through passage OD-3-1.

View 3. During Initial Application

⑤ When the shift valve moves in, control pressure is routed to the 1-2 capacity modulator valve for intermediate clutch application.

⑥ The 1-2 capacity modulator valve goes into balanced operation and produces a reduced or regulated pressure. Regulation occurs in the flow from the D2 to the INT CL passage at the valve.

⑦ The regulated pressure is applied to the intermediate clutch.

⑧ It is also applied to the spring (outer) end of the 1-2 accumulator through orifice F. Then, the regulated pressure is effective on the outer end of the accumulator and forces the accumulator to move down.

Pressure regulation continues until the accumulator is fully bottomed in its bore (fully inward).

View 4. Full Application

⑨ When the accumulator bottoms, there is no longer any fluid flow from the D2 passage to the INT CL passage at the capacity modulator valve.

⑩ Thus the valve ceases to regulate; and pressure in the entire network rises to full line pressure.

NO "TORQUE DEMAND" DOWNSHIFT TO 1ST GEAR

When the 1-2 shift valve moves in, both of the shift delay pressures (Figure 51) are blocked from the valve. Therefore, increased T.V. cannot force a downshift. A downshift to low gear can occur only when the Kickdown System is activated, as we will describe later, or a "coasting" downshift, of course, when governor pressure is low enough.

AUTOMATIC 2-3 UPSHIFT

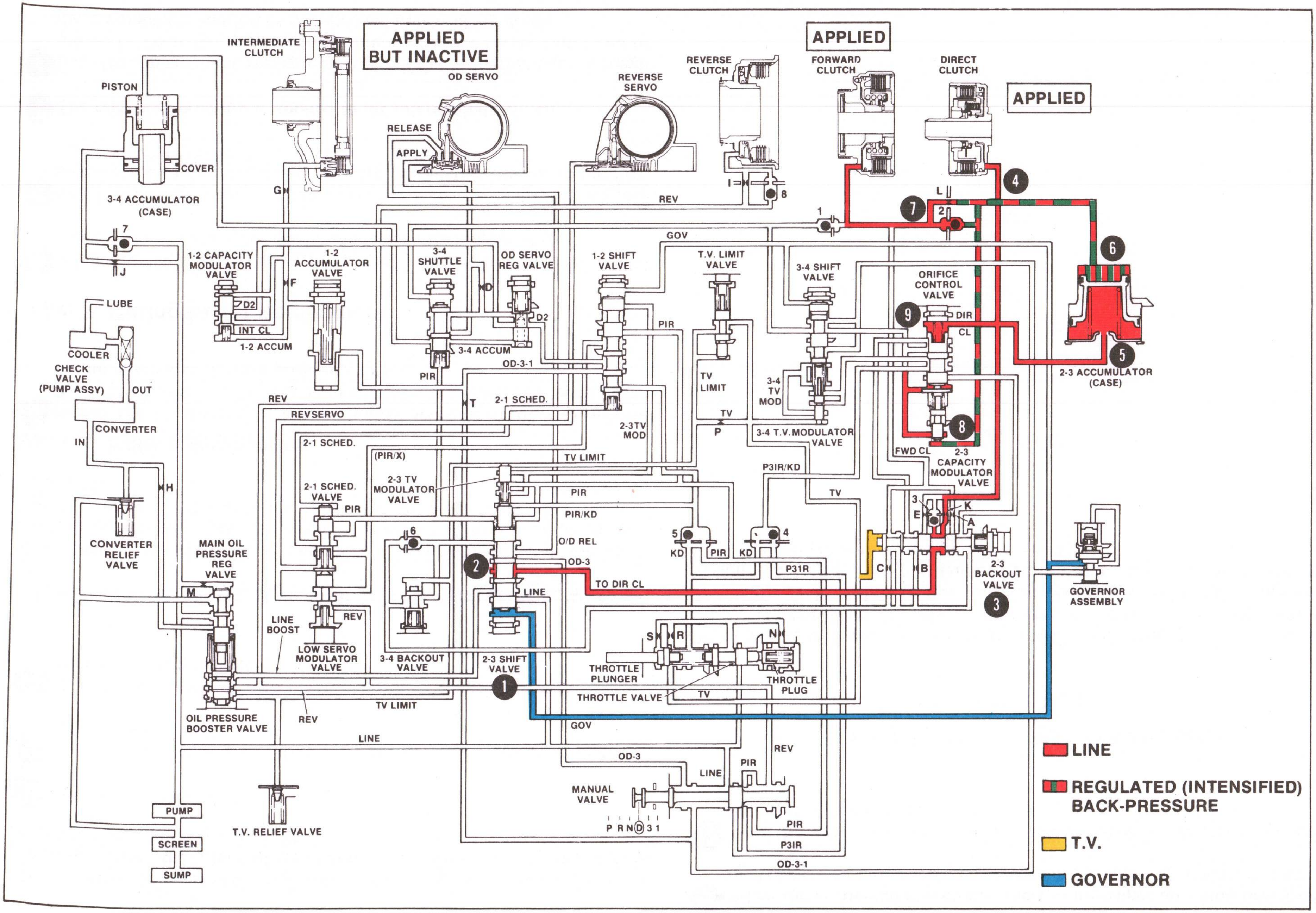


Figure 54 — Overdrive Range 2-3 Upshift at Part Throttle

For the 2-3 upshift, it is necessary only to apply the direct clutch. The forward clutch remains applied as in first and second gears. The intermediate clutch also remains applied; but the intermediate one-way clutch overruns in third gear. Thus, the active "holding members" (Figure 54), when the shift is completed, are the forward and direct clutches.

DIRECT CLUTCH APPLICATION

❶ Governor pressure moves the 2-3 shift valve to the inward or upshifted position.

NOTE: The shift valve "bottoms" on the valve body casting and it still allows the 2-3 T.V. modulator valve to regulate if the T.V. limit pressure is high enough.

❷ The shift valve connects line pressure from the OD-3 passage to charge the DIR CL passage.

❸ The DIR CL passage leads to the 2-3 backout valve; which is outward at part throttle. Pressure here forces the #3 check ball to seat; and clutch apply pressure must go through orifice K.

NOTE: If the throttle is closed, the backout valve will be inward and the pressure applied through orifice E.

❹ Pressure in the DIR CL passage continues to the direct clutch, and to the spring end of the 2-3 accumulator.

CUSHIONING THE UPSHIFT

Referring back to Figures 52 and 53, you can see that the 2-3 accumulator was held down by forward clutch apply pressure in first and second gears. During the 2-3 upshift, the accumulator moves up; and it controls the direct clutch apply pressure as follows:

❺ DIR CL pressure downstream from orifice K (or E) assists the accumulator spring to force the accumulator upward.

❻ This causes an intensified "back-pressure" flow out of the smaller (upper) end of the accumulator chamber. (By intensified, we mean that the pressure is higher than line pressure.)

❼ The "back-pressure" causes the check ball #2 to seat. (A small amount of oil also flows through orifice L.)

❽ The fluid from the accumulator thus must escape past the 2-3 capacity modulator valve. The modulator valve moves outward and regulates the flow.

Regulating this back-pressure controls the force on the accumulator; and therefore controls the direct clutch apply pressure ❹ during the shift.

When the accumulator reaches the end of its travel, there is no longer any flow. Direct clutch apply pressure then rises to full line.

❾ DIR CL pressure forces the orifice control valve inward at this time.

CONTROL PRESSURE CUTBACK

As with other Ford transmissions, line pressure cuts back from stall pressure to a lower pressure. This system eliminates the usual cutback valve by incorporating the cutback function with the 2-3 shift valve. When the 2-3 shift valve is outward, line pressure flows through the 2-3 shift valve to the booster valve which, as we have seen earlier, raises line pressure. When the 2-3 shift valve moves inward at the 2-3 shift, the line pressure boost signal is dropped and line pressure immediately drops or cuts back. Thus the line pressure is lower for third and fourth gears than it is for first and second.

AUTOMATIC 3-4 UPSHIFT

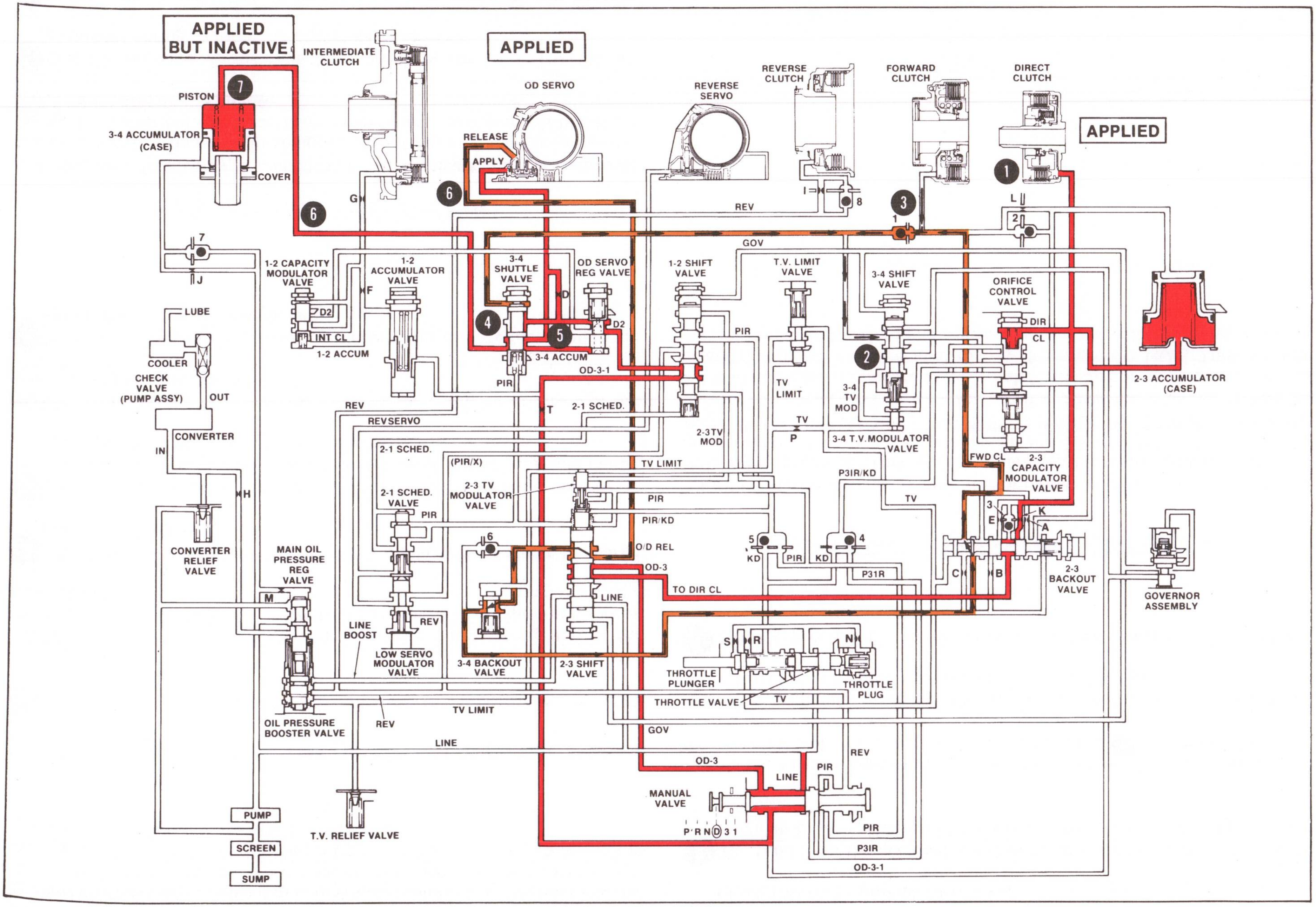


Figure 55 — Overdrive Range 3-4 Upshift

To accomplish the upshift to overdrive, it is necessary to:

- Release the forward clutch.
- Convert O.D. servo apply pressure from regulated pressure to line pressure, and
- Exhaust the O.D. servo release pressure.

This occurs when governor pressure is high enough to force the 3-4 shift valve inward (Figure 55). The O.D. servo release and the forward clutch are tied together through the 3-4 backout valve, 2-3 valve and 2-3 backout valve.

❶ The direct clutch remains applied from the 2-3 shift valve.

❷ The 3-4 shift valve, moving in, opens the forward clutch circuit to exhaust. At the same time, it blocks OD-3-1 pressure from applying the clutch.

❸ The forward clutch and O.D. servo release pressure exhaust through the #1 check valve and the 3-4 shift valve.

❹ Pressure on the outer end of the 3-4 shuttle valve also exhausts. The valve moves out.

❺ Now the O.D. servo valve stops regulating and puts out line pressure.

❻ Orifice D connects pressure from the O.D. servo valve to the servo apply side and to the top of the 3-4 accumulator.

❼ The accumulator moves down, causing the pressure to be less than line during its movement. (The pressure is determined by accumulator spring force and by line pressure on the differential area under the accumulator.)

This controlled pressure, acting on the servo piston, provides a controlled band capacity for a smooth 3-4 upshift.

As soon as the accumulator bottoms, the controlled pressure rises to full line pressure.

KICKDOWN SYSTEM

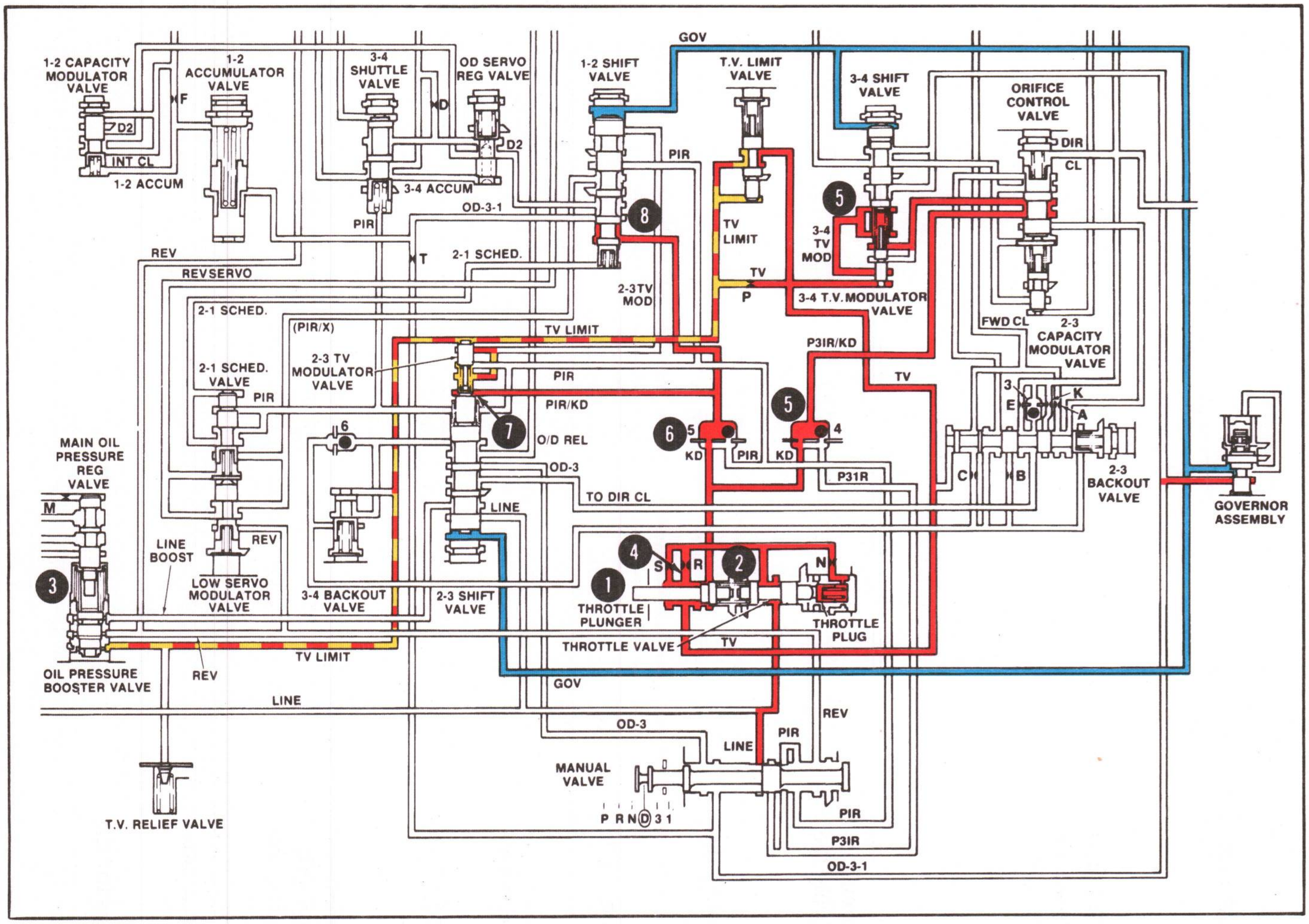


Figure 56 — Kickdown System

WIDE-OPEN THROTTLE DOWNSHIFTS

The Kickdown System (Figure 56) operates to force a downshift at wide-open throttle. Here's how it works:

① The throttle plunger forces the throttle valve in to fully uncover the LINE passage.

② T.V. pressure becomes equal to line pressure.

③ T.V. limit pressure acts on the pressure booster valve to increase line pressure.

NOTE: This action alone can cause "torque demand" downshifting due to increased T.V. system pressures. At wide-open throttle, the following also occur:

④ T.V. (line) pressure is effective through the KD passage, which is opened with the plunger pushed fully in.

⑤ KD pressure through the #4 shuttle valve is applied **between** the 3-4 shift valve and the 3-4 T.V. modulator valve. This pressure acts on the spring end of the shift valve to overcome governor pressure and downshift the valve at **any** vehicle speed. (The transmission **cannot** stay in overdrive at wide-open throttle.)

⑥ KD pressure also acts through shuttle valve #5 on the 1-2 shift valve and on the 2-3 shift valve.

⑦ On the 2-3 shift valve, the pressure is applied to a differential area between the two innermost bands. (Modulated T.V. pressure also can assist with a downshift.)

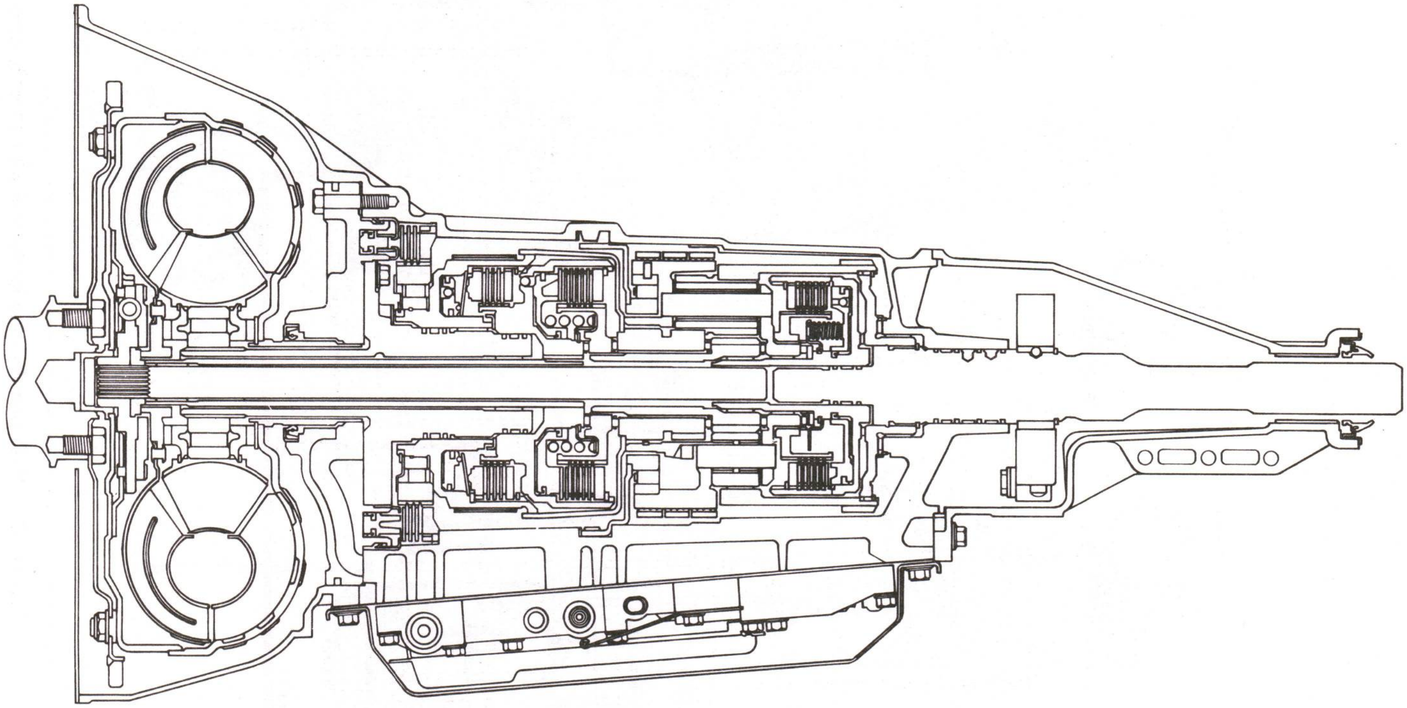
⑧ On the 1-2 shift valve, KD pressure is effective on two differential areas. (T.V. pressure has no effect on this valve in the upshifted position.)

The "kickdown" shift to second or first gear depends on whether road speed is low enough that KD pressure can overcome the force of governor pressure.

AUTOMATIC OVERDRIVE TRANSMISSION

SECTION 5

HYDRAULIC SYSTEM SCHEMATICS



NEUTRAL — CLOSED THROTTLE

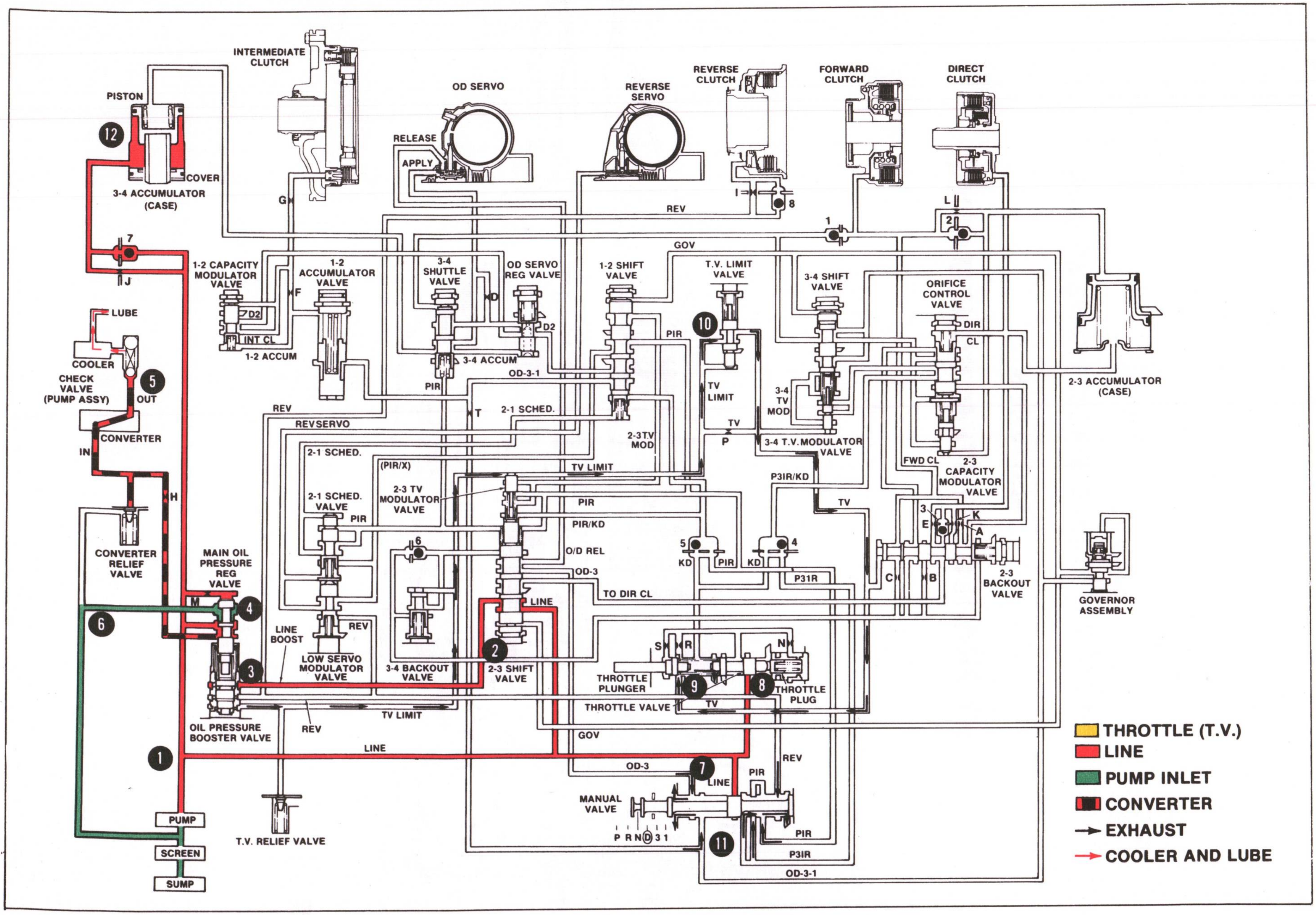


Figure 57 — Hydraulic System in Neutral with Throttle Closed

HYDRAULIC CIRCUIT DIAGRAMS

In the pages following, we will show a full system schematic for each operating mode or gear; that is, for neutral, park, all four gears in overdrive range, and manual low. In Range 3, only third gear will be shown, since the operation of first and second gears is identical to overdrive range. Third gear of 3 range shows how fourth gear is locked out.

The schematics will not be able to show everything that can happen in each mode; but only the typical or average driving condition. These conditions should give you enough knowledge to diagnose the transmission during road testing and other diagnostic procedures.

NEUTRAL — CLOSED THROTTLE

Figure 57 shows the system hydraulics in Neutral range with the throttle closed and the engine running at idle.

❶ The pump is supplying the Main Control Pressure System.

❷ The LINE BOOST passage is charged through the 2-3 shift valve.

❸ LINE BOOST pressure acts on the pressure booster valve to increase main control (line) pressure.

❹ The main oil pressure regulator valve is regulating line pressure and charging the converter circuit.

❺ Converter-out fluid is flowing to the oil cooler and back to the lube system.

❻ Excess pump delivery is returned to the inlet by the main oil pressure regulator valve.

❼ Line pressure is blocked at the manual valve, so that no clutches or servos are applied.

❽ The throttle valve is regulating but . . .

❾ T.V. pressure going to the rest of the valves is exhausted.

❿ The T.V. limit system is, therefore, also exhausted. Thus there is no T.V. pressure in the system.

⓫ All passages at the manual valve, except LINE, are exhausted.

⓬ The 3-4 accumulator is charged by line pressure under the piston. The piston is forced upward and its spring is compressed.

PARK — CLOSED THROTTLE

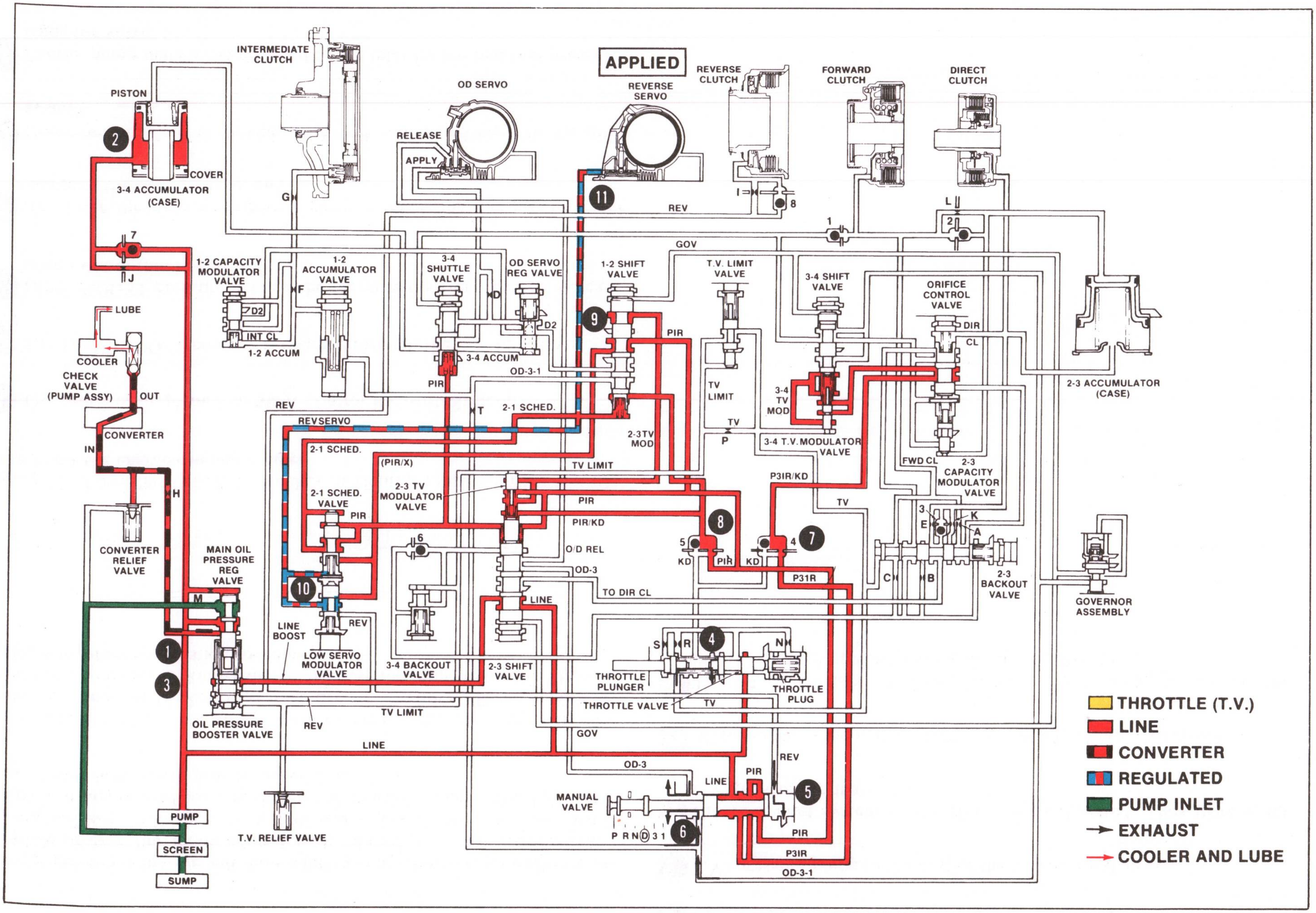


Fig. 58 — Hydraulic System In Park With Throttle Closed

PARK — CLOSED THROTTLE

As mentioned earlier, there is no drive through the transmission in Park. However, there are several passages charged at the manual valve and there is apply pressure on the low-reverse servo.

The Park range hydraulic system with the engine at curb idle is shown in Figure 58.

1 The Main Control Pressure System is regulating pressure of the fluid from the pump. Fluid is flowing from the regulator valve, through the converter, cooler and lube circuits.

2 The 3-4 accumulator is moved upward by line pressure under the piston.

3 Since the 2-3 shift valve is outward, LINE BOOST pressure is causing line pressure to increase.

4 T.V. pressure is exhausted just as in neutral closed throttle. Thus, there is no T.V. pressure in the system.

5 The REV passage is exhausted at the manual valve. Thus, the low servo modulator valve cannot send full line pressure to apply the low-reverse servo.

6 The OD-3 and OD-3-1 passages also are exhausted at the manual valve. Thus, there is no charging of the OD REL passage; and also the Forward Clutch and Governor System is exhausted.

7 The P-3-1-R passage is charged. Shuttle valve #4 opens this passage to the P-3-1-R/KD passage. Line pressure is applied through the orifice control valve to the 3-4 shift valve.

8 The P-1-R passage also is charged. Shuttle valve #5 allows the P-1-R/KD passage to be charged also. Control pressure is directed to the 1-2 shift valve, 2-3 T.V. modulator valve, 3-4 shuttle valve, and 2-1 scheduling valve.

9 The P-1-R passage charges the P-1-R/X passage through the 1-2 shift valve. This sends line pressure to the low servo modulator valve.

10 The low servo modulator valve operates as a regulator valve, since the REV passage is exhausted.

11 Regulated pressure is applied to the low-reverse servo through the REV SERVO passage.

MANUAL LOW (RANGE 1, 1ST GEAR)

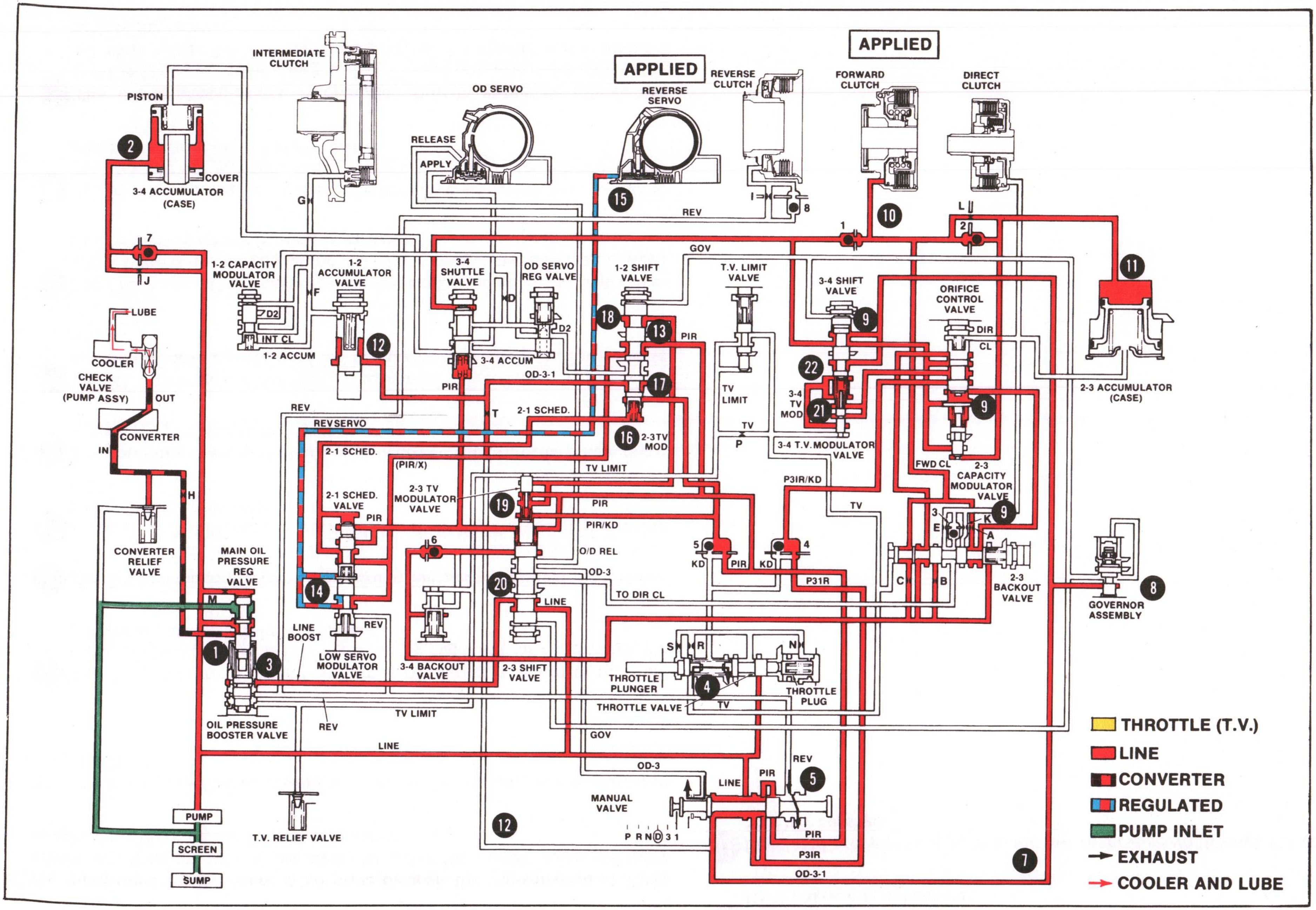


Figure 59 — Manual Low Engagement at Closed Throttle and Zero Miles-Per-Hour

MANUAL LOW 1ST GEAR

In manual low (Figure 59), we have the forward clutch applied to drive the forward sun gear and the low-reverse band applied for coast-down engine braking. The low (planetary) one-way clutch also holds when engine driving torque is applied. The schematic shows initial engagement before the wheels begin to turn; and with the engine at curb idle.

MAIN CONTROL AND CONVERTER SYSTEMS

① The Main Control Pressure System is regulating pressure of the fluid from the pump. Fluid is flowing from the regulator valve, through the converter, cooler and lube circuits.

② The 3-4 accumulator is moved upward by line pressure under the piston.

③ Since the 2-3 shift valve is outward, LINE BOOST pressure is causing line pressure to increase.

T.V. SYSTEM

④ T.V. pressure is exhausted just as in neutral closed throttle. Thus there is no T.V. pressure in the system.

EXHAUSTED PASSAGES

⑤ The REV passage is exhausted at the manual valve. Thus, the low servo modulator valve cannot send full line pressure to apply the low-reverse servo.

⑥ The OD-3 passage also is exhausted at the manual valve; so there is no release pressure on the overdrive servo.

FORWARD CLUTCH AND GOVERNOR

⑦ The OD-3-1 passage from the manual valve charges the forward clutch and governor system.

⑧ There is no governor output until the vehicle begins to move.

⑨ Pressure continues through the 3-4 shift valve and orifice control valve; then through the A orifice to the FWD CL passage.

⑩ The FWD CL passage pressurizes and applies the forward clutch.

⑪ Forward clutch apply pressure forces the 2-3 accumulator down, and in doing so cushions the engagement.

⑫ OD-3-1 pressure is also effective on the 1-2 accumulator valve forcing it outward.

LOW-REVERSE SERVO APPLY

⑬ The P-1-R passage charges the P-1-R/X passage through the 1-2 shift valve. This sends line pressure to the low servo modulator valve.

⑭ The low servo modulator valve operates as a regulator valve, since the REV passage is exhausted.

⑮ Regulated pressure is applied to the low-reverse servo through the REV SERVO passage.

UPSHIFT LOCKOUT

The 1-2 shift valve is prevented from moving in by:

⑯ Line pressure in the 2-1 SCHED passage on the spring end of the valve.

⑰ Line pressure applied to differential areas between lands.

⑱ Line pressure in the 2-3 TV MOD passage applied to a differential area between lands.

A 1-3 shift is prevented by pressures on the 2-3 shift valve.

⑲ P-1-R line pressure on the spring end and differential areas.

⑳ Pressure in the LINE passage acting on a differential area.

And a 1-4 shift is prevented by pressures on the 3-4 shift valve:

㉑ Line pressure is effective at the spring end of the valve.

㉒ OD-D-1 line pressure acts on a differential area between lands.

1ST GEAR IN OVERDRIVE RANGE

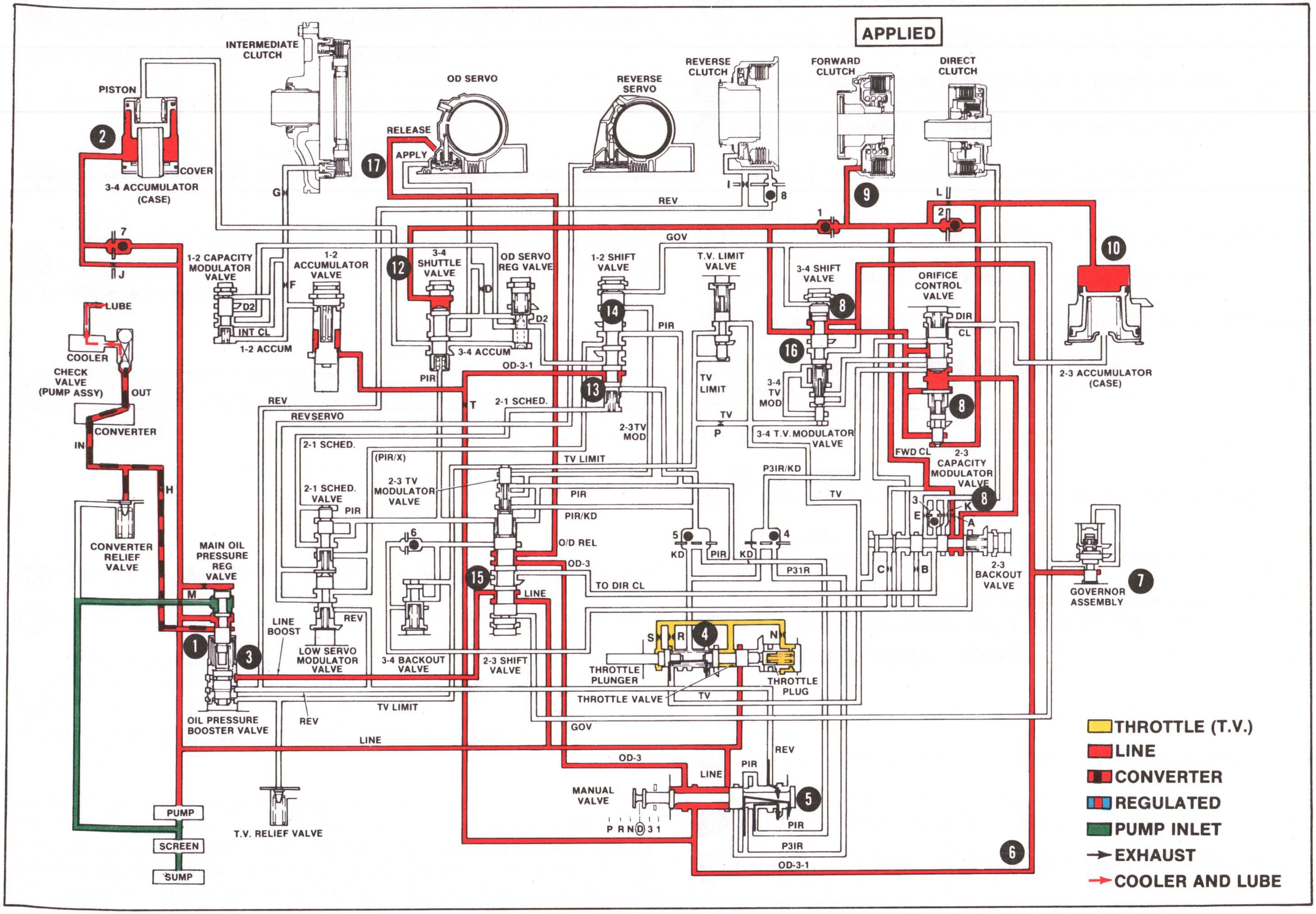


Figure 60 — First Gear Engagement in Overdrive Range (Closed Throttle)

FIRST GEAR ENGAGEMENT

We are showing first gear engagement at closed throttle in overdrive range in Figure 60. The schematic would be essentially the same in range 3, except for the charging of another passage for fourth gear lockout.

MAIN CONTROL AND CONVERTER SYSTEMS

① The Main Control Pressure System is regulating pressure of the fluid from the pump. Fluid is flowing from the regulator valve, through the converter, cooler and lube circuits.

② The 3-4 accumulator is moved upward by line pressure under the spring.

③ Since the 2-3 shift valve is outward, LINE BOOST pressure is causing line pressure to increase.

EXHAUSTED PASSAGES

④ T.V. pressure is exhausted and there is no T.V. pressure in the system until the throttle opens.

⑤ The REV, P-1-R and P-3-1-R passages are exhausted at the manual valve.

FORWARD CLUTCH AND GOVERNOR

⑥ The OD-3-1 passage from the manual valve charges the forward clutch and governor system.

⑦ There is no governor output until the vehicle begins to move.

⑧ Pressure continues through the 3-4 shift valve and orifice control valve; then through the A orifice to the FWD CL passage.

⑨ The FWD CL passage pressurizes and applies the forward clutch.

⑩ Forward clutch apply pressure forces the 2-3 accumulator down and as the accumulator moves down against the spring it controls the apply pressure for a smooth forward clutch engagement.

⑪ OD-3-1 pressure is also effective on the 1-2 accumulator, forcing it outward.

⑫ OD-3-1 pressure through the 3-4 shift valve also holds the 3-4 shuttle valve inward.

UPSHIFT DELAY

⑬ OD-3-1 line pressure is effective on a differential area of the 1-2 shift valve to oppose governor pressure.

⑭ When the throttle opens, and T.V. limit pressure becomes high enough to move the 2-3 T.V. modulator valve into regulation, additional pressure will be applied to a differential area between the outer lands of the 1-2 shift valve.

⑮ Pressure in the LINE passage acts on a differential area of the 2-3 shift valve to oppose governor pressure.

⑯ Line pressure is effective on the 3-4 shift valve to hold it outward.

O.D. SERVO RELEASE

⑰ The OD-3 passage is charged and applies line pressure to the release side of the overdrive servo.

2ND GEAR IN OVERDRIVE RANGE

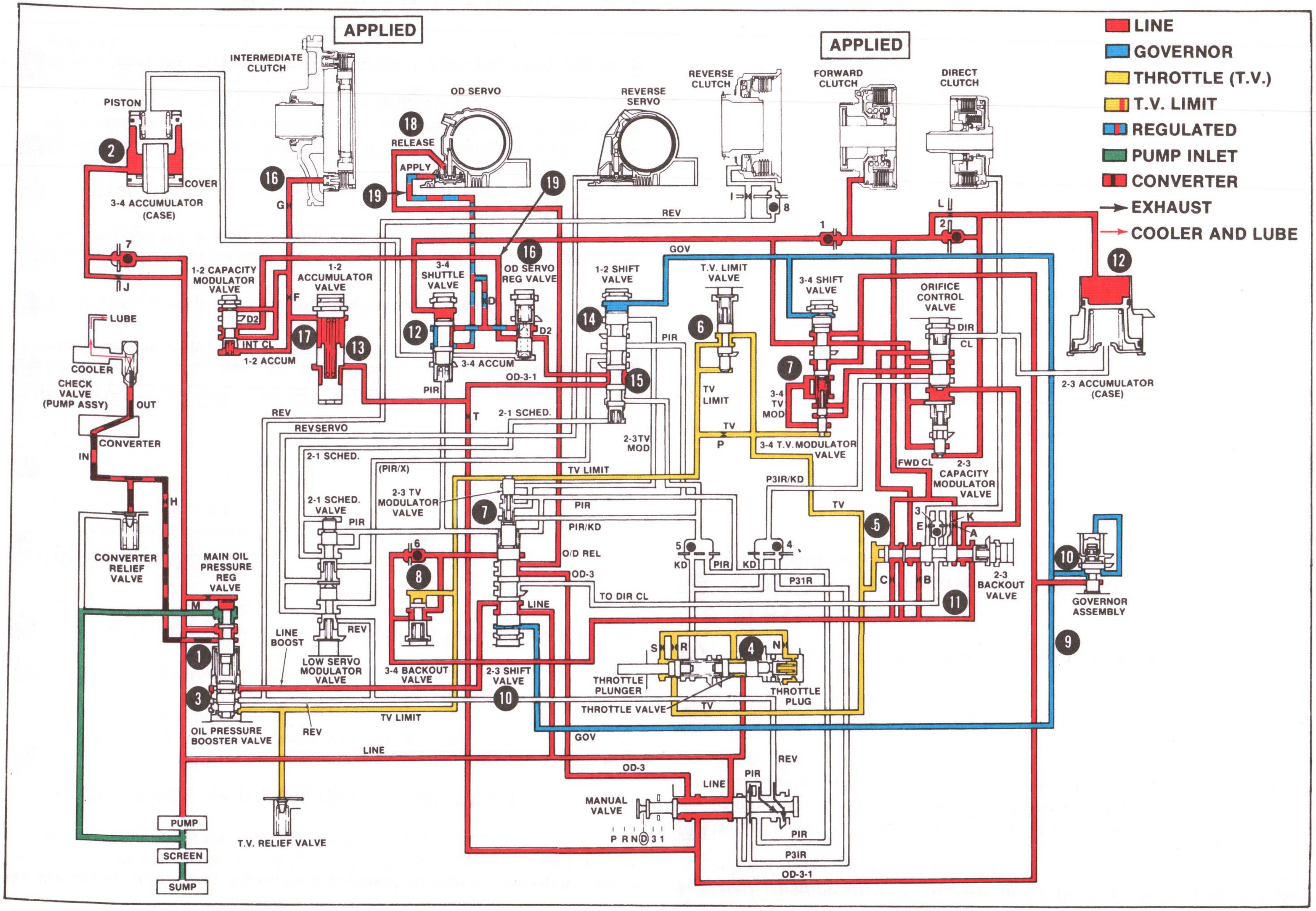


Figure 61 — Second Gear at Part Throttle in Overdrive Range

SECOND GEAR IN O/D RANGE

Figure 61 shows the hydraulic system with the upshift to second gear just completed at part throttle. The forward clutch remains applied from first gear; and the intermediate clutch has been applied by movement of the 1-2 shift valve.

MAIN CONTROL AND CONVERTER SYSTEMS

❶ The Main Control Pressure System is regulating pressure of the fluid from the pump. Fluid is flowing from the regulator valve, through the converter, cooler and lube circuits.

❷ The 3-4 accumulator is moved upward by line pressure under the spring.

❸ Since the 2-3 shift valve is still outward, LINE BOOST pressure is causing line pressure increase. Also, because we now have T.V., the oil pressure booster valve is butting against the regulator valve, to increase line pressure as T.V. increases.

T.V. SYSTEM

❹ The throttle plunger has moved in, and the throttle valve is producing a regulated T.V. pressure in the range of 30 psi.

❺ T.V. pressure moves the 2-3 backout valve outward.

❻ T.V. pressure flows to and through the T.V. limit valve. (Remember the T.V. must reach approximately 85 psi before the valve begins to regulate.)

❼ Because of low T.V. pressure, the T.V. modulator valves are not producing modulated pressure to delay upshifts.

❽ T.V. limit pressure moves the 3-4 backout valve outward.

FORWARD CLUTCH AND GOVERNOR

❾ The OD-3-1 passage is charged and line pressure is available to the governor and forward clutch.

❿ The vehicle is moving, so the governor sends a "road-speed" pressure signal to all the shift valves.

⓫ Because of T.V. pressure on the 2-3 backout valve, forward clutch apply pressure takes a different route through the valve. Orifice A is bypassed.

⓬ Clutch apply pressure continues to hold the 2-3 accumulator down; and the 3-4 shuttle valve in.

⓭ OD-3-1 pressure remains effective on the differential area of the 1-2 accumulator.

INTERMEDIATE CLUTCH APPLY

⓮ Governor pressure has moved the 1-2 shift valve in.

⓯ The OD-3-1 passage is now open to the O.D. servo regulator valve.

⓰ OD-3-1 pressure is transmitted through the 1-2 capacity modulator to the INT. CL passage. The clutch is applied.

⓱ The apply pressure is effective, through orifice F, to the spring end of the 1-2 accumulator. The accumulator has moved down to cushion the clutch application.

O.D. SERVO

⓲ Line pressure is applied to the overdrive servo release side through the OD-3 and OD REL passages.

⓳ The OD servo regulator valve produces a regulated pressure to the apply side of the servo. (Pressure ⓲ keeps the servo released.)

3RD GEAR IN OVERDRIVE RANGE

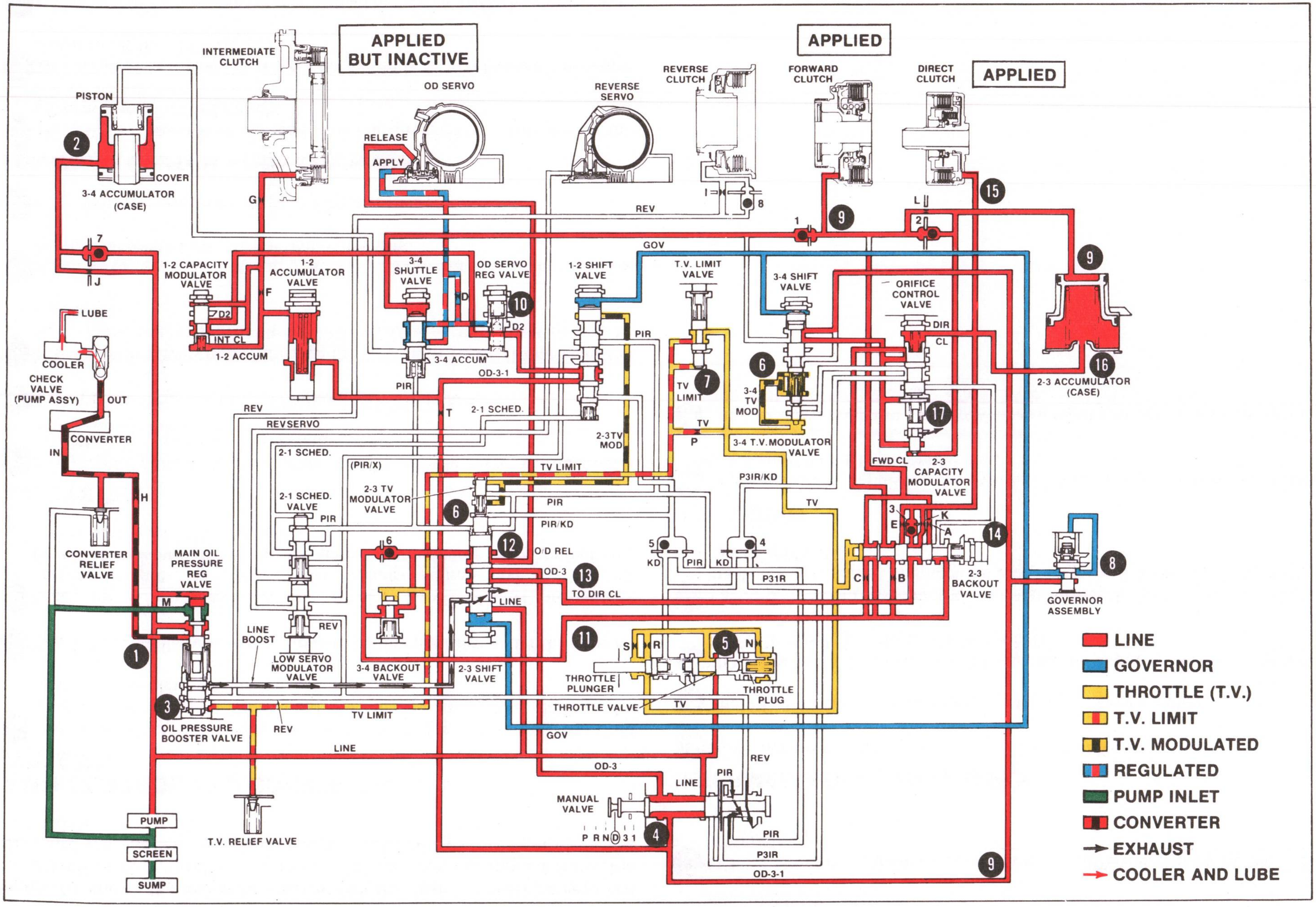


Figure 62 — Third Gear at Three-Fourths Throttle in Overdrive Range

ACCELERATING IN 3RD

For third gear, it is necessary to apply the direct clutch, so that the direct drive input shaft can drive the planet carrier. The forward clutch remains applied as in first and second. The intermediate clutch also remains applied. However, it does not affect the drive, since the intermediate one-way clutch overruns.

Third gear in overdrive range is shown in Figure 62. The throttle is about three-fourths open; so the vehicle is accelerating with a heavy engine load.

MAIN CONTROL PRESSURE SYSTEM

❶ High output volume from the pump is being controlled by the regulator valve. The converter, cooler and lube systems receive a constant flow of fluid from the regulator valve.

❷ The 3-4 accumulator is forced up, preparatory to cushioning the 3-4 upshift.

❸ T.V. limit pressure is increasing line pressure as required by the engine load. LINE BOOST is exhausted.

❹ The OD-3 and OD-3-1 passages are charged at the manual valve with line pressure. (The P-1-R, P-3-1-R and REV passages are exhausted.)

T.V. SYSTEMS

❺ The throttle valve is producing a high T.V. pressure. This pressure holds the 2-3 backout valve outward.

❻ The 3-4 T.V. modulator valve is regulating modulated T.V. pressure to the 3-4 shift valve.

❼ The T.V. limit valve is regulating T.V. limit pressure at about 85 psi. T.V. limit pressure moves the 3-4 backout valve out and causes the 2-3 T.V. modulator valve to regulate.

OD-3-1 PASSAGES

Pressure in the OD-3-1 passages is functioning the same as in second gear:

❽ Line pressure is available to the governor; which is regulating governor pressure in response to road speed.

❾ The forward clutch is applied and the top of the 2-3 accumulator is pressurized.

❿ The O.D. servo regulator valve is regulating apply pressure to the servo. Line pressure is applying the intermediate clutch.

2-3 UPSHIFT

The 2-3 upshift has been caused by governor pressure moving the 2-3 shift valve inward.

⓫ OD REL is now pressurized from the forward clutch apply system instead of the OD-3 passage.

⓬ The OD-3 passage has pressurized the DIR CL passage.

⓭ Direct clutch apply pressure was routed through orifice K.

⓮ The clutch is applied from the DIR CL passage.

⓯ DIR CL pressure has moved the 2-3 accumulator up to cushion the shift.

⓰ Fluid above the accumulator seated check valve #2 and flowed past the 2-3 capacity modulator valve. The valve operated in regulation during the shift to control the accumulator backpressure. The shift completed, the valve has returned to its normal ''in'' position.

3RD GEAR IN RANGE 3 (OVERDRIVE LOCKOUT)

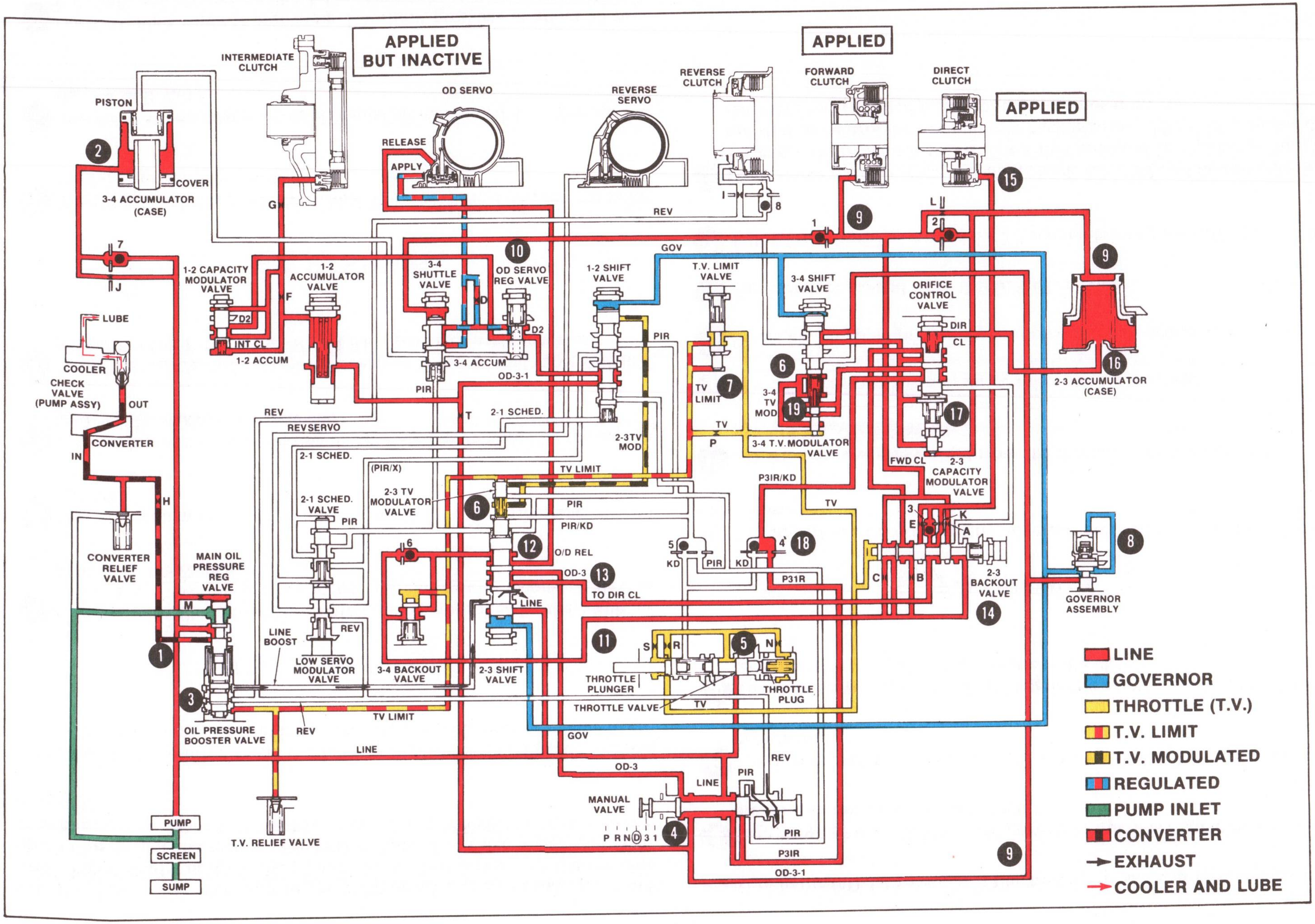


Figure 63 — Third Gear at Three-Fourths Throttle in Range 3

ACCELERATING IN 3RD

Figure 63 illustrates a condition of accelerating in third gear (direct drive) in range 3. For the most part, the hydraulic system is the same as in third gear in overdrive range (Figure 62). The difference is that the fourth gear lockout is actuated through passage P-3-1-R from the manual valve.

The operation is shown accelerating at three-fourths throttle opening, with high T.V. pressure.

MAIN CONTROL PRESSURE SYSTEM

❶ High output volume from the pump is being controlled by the regulator valve. The converter, cooler and lube systems receive a constant flow of fluid from the regulator valve.

❷ The 3-4 accumulator is forced up.

❸ T.V. limit pressure is increasing line pressure as required by the engine load. LINE BOOST is exhausted.

❹ The OD-3, P-3-1-R and OD-3-1 passages are charged at the manual valve with line pressure. (The P-1-R and REV passages are exhausted.)

T.V. SYSTEMS

❺ The throttle valve is producing a high T.V. pressure. The 2-3 backout valve is outward.

❻ Unlike Figure 62, the 3-4 T.V. modulator valve is being held inward and the 3-4 shift valve held outward by line pressure coming through the orifice control valve from the P-3-1-R circuit.

❼ The T.V. limit valve is regulating T.V. limit pressure at about 85 psi. T.V. limit pressure moves the 3-4 backout valve out and causes the 2-3 T.V. modulator valve to regulate.

OD-3-1 PASSAGES

Pressure in the OD-3-1 passages is functioning the same as in second gear.

❽ Line pressure is available to the governor; which is regulating governor pressure in response to road speed.

❾ The forward clutch is applied and the top of the 2-3 accumulator is pressurized.

❿ The O.D. servo regulator valve is regulating apply pressure to the servo. Line pressure is applying the intermediate clutch.

2-3 UPSHIFT

The 2-3 upshift has been caused by governor pressure moving the 2-3 shift valve inward.

⓫ OD REL is now pressurized from the forward clutch apply system instead of the OD-3 passage.

⓬ The OD-3 passage has pressurized the DIR CL passage.

⓭ Direct clutch apply pressure was routed through orifice K.

⓮ The clutch is applied from the DIR CL passage.

⓯ DIR CL pressure has moved the 2-3 accumulator up to cushion the shift.

⓰ Fluid above the accumulator seated check valve #2 and flowed past the 2-3 capacity modulator valve. The valve operated in regulation during the shift to control the accumulator backpressure. The shift completed, the valve has returned to its normal ''in'' position.

OVERDRIVE LOCKOUT

⓱ Overdrive lockout is through the P-3-1-R passage at the manual valve and through shuttle valve #4 to the P-3-1-R/KD passage. With the orifice control valve in as shown, this pressure continues to the bore between the 3-4 shift valve and the 3-4 T.V. modulator valve.

⓲ Line pressure then is effective on the spring end of the 3-4 shift valve to prevent an upshift to overdrive. It also forces the 3-4 T.V. modulator valve to its normal (in) position.

OVERDRIVE (4TH GEAR)

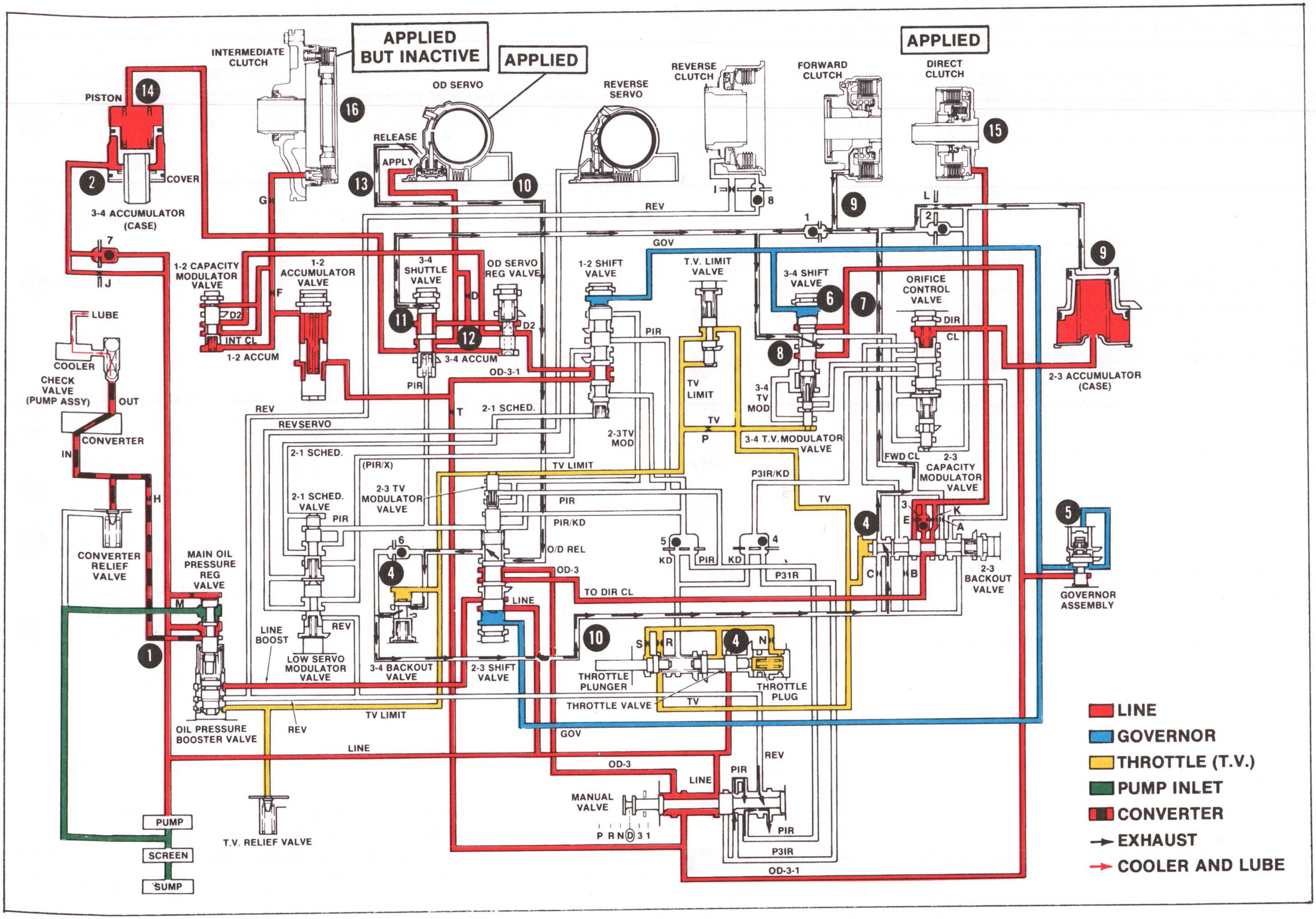


Figure 64 — Fourth Gear (Overdrive) at Part Throttle

CRUISING IN OVERDRIVE

Figure 64 shows the hydraulic system after the driver has eased off to part throttle and the 3-4 upshift has occurred. To get into overdrive, remember, the overdrive servo must be applied and the forward clutch must be released.

MAIN CONTROL AND CONVERTER SYSTEMS

❶ The main control pressure valve is regulating line pressure and feeding the converter and lube systems.

❷ Line pressure is applied under the 3-4 accumulator piston.

❸ The OD-3 and OD-3-1 passages are charged at the manual valve. Thus there is supply pressure to the governor and to the O.D. servo regulator valve.

T.V. SYSTEMS

❹ The throttle valve is regulating a moderate T.V. pressure; around 30 psi. The 2-3 and 3-4 backout valves are forced outward by T.V. and T.V. limit pressure.

FORWARD CLUTCH AND GOVERNOR SYSTEM

❺ The governor is regulating at high pressure due to high road speed.

❻ Governor pressure has forced the 3-4 shift valve inward.

❼ The pressure apply passage for the forward clutch is now blocked at the 3-4 shift valve.

Remembering now that the O.D. servo release and front clutch apply passages are tied together by the backout valves and the 2-3 shift valve, we can see how the upshift has occurred.

3-4 UPSHIFT

❽ The 3-4 shift valve has opened the forward clutch apply systems to an exhaust passage.

❾ The forward clutch is exhausted, along with the top of the 2-3 accumulator.

❿ The O.D. servo release pressure is exhausted through the 2-3 shift valve, 3-4 backout valve, and 2-3 backout valve.

⓫ Pressure at the end of the 3-4 shuttle valve is exhausted and the valve moves out.

⓬ OD-3-1 pressure is now effective at the inner end of the O.D. servo regulator valve. This pressure, through the drilled hole in the valve, also acts on the outer end of the valve and moves it inward. The valve stops regulating and sends out line pressure.

⓭ Full line pressure is applied to the servo apply side through orifice D.

⓮ Servo apply pressure also is effective above the 3-4 accumulator which moved down to cushion the upshift.

DIRECT AND INTERMEDIATE CLUTCHES

⓯ The direct clutch remains applied from the 2-3 shift valve through the DIR CL passages.

⓰ The intermediate clutch also remains applied, but is inactive.

REVERSE GEAR

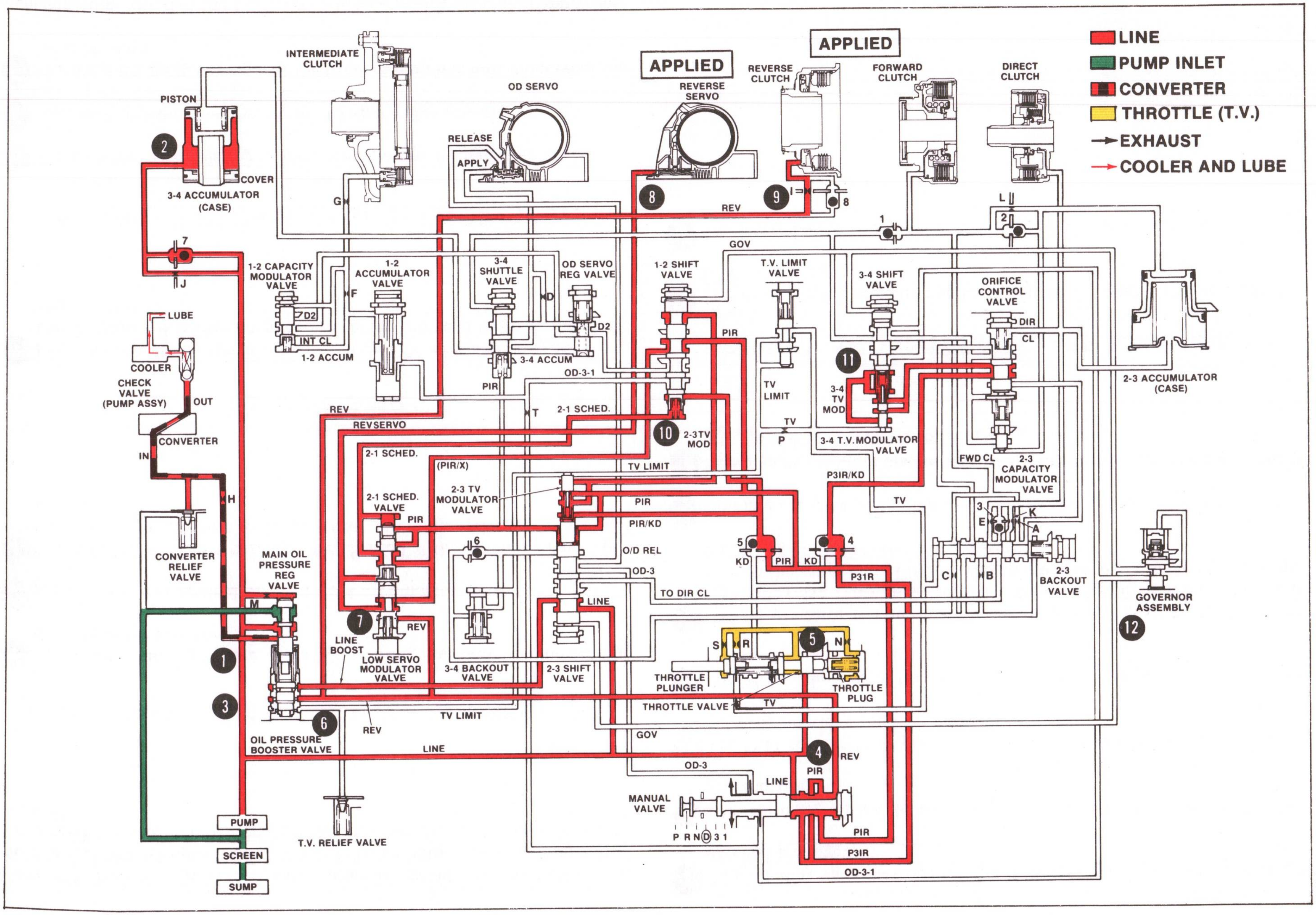


Figure 65 — Reverse Gear at Initial Engagement with Closed Throttle

REVERSE GEAR ENGAGEMENT

In reverse gear, remember, it is necessary to apply the low-reverse band and the reverse clutch. If the selector is in Park initially, the band servo already has a regulated apply pressure, which changes to full line when R is selected.

Figure 65 illustrates the hydraulic system at reverse engagement with the throttle closed.

MAIN CONTROL AND CONVERTER SYSTEMS

❶ The main control pressure system is regulating. Fluid is flowing from the regulator valve through the converter, cooler and lube circuits.

❷ The 3-4 accumulator is forced up by line pressure.

❸ Line pressure is increased by LINE BOOST and REV boost pressures acting on differential areas of the oil pressure booster valve.

❹ At the manual valve, the REV, P-1-R and P-3-1-R passages are charged by line pressure. (The OD-3 and OD-3-1 passages are exhausted.)

T.V. SYSTEMS

❺ With the throttle closed, T.V. pressure is zero.

❻ When the throttle is opened to move the vehicle, the T.V. passages will be charged. T.V. limit pressure will further increase line pressure by acting on the oil pressure booster valve. (Maximum line pressure occurs in Reverse with three pressures acting on the booster valve.)

SERVO AND CLUTCH APPLY

❼ The low servo modulator valve is forced outward by line pressure on the differential area. This opens the REV passage to the REV SERVO passage.

❽ The reverse servo is applied by full line pressure in the REV SERVO passage.

❾ The reverse clutch is applied with full line pressure from the REV passage. Orifice I delays the clutch application slightly so that the band will always apply first. This smooths the engagement.

P-1-R AND P-3-1-R SYSTEMS

❿ Other passages in the valve body are charged from P-1-R (such as 2-1 SCHED, 2-3 T.V. MOD, etc.) but have no effect on reverse operation.

⓫ The P-3-1-R passage is also charged, so pressure is applied to the 3-4 shift valve through the orifice control valve. This, you'll recall, is the fourth gear lockout for range 3. It likewise has no effect on reverse.

GOVERNOR

⓬ Since the OD-3-1 passage is exhausted, the governor is inactive in Reverse.

2ND GEAR IN MANUAL LOW RANGE

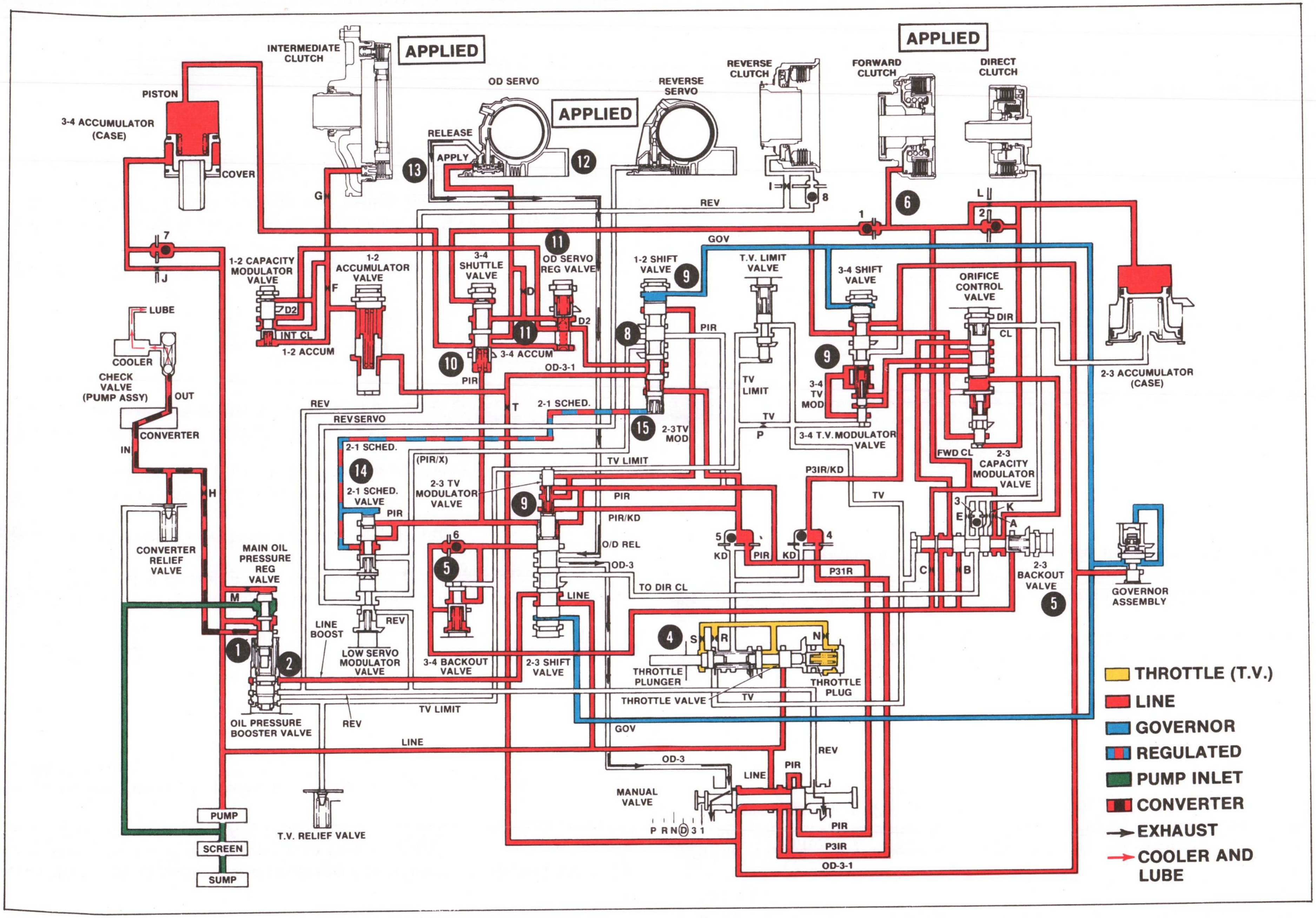


Figure 66 — Manual Low at Closed Throttle Above the 2-1 Shift MPH

2ND GEAR ENGINE BRAKING

Recall now that the intermediate one-way clutch overruns when the vehicle is coasting down in second gear in the overdrive or 3 range; so there is no engine braking. However, when the driver shifts to range 1 (manual low) at a high road speed, the transmission shifts into second gear initially; then downshifts to low (first) in the 25 MPH range. In this condition, we **do** have second gear engine braking; and it is accomplished by applying the overdrive band so the reverse clutch drum can't turn counterclockwise.

Figure 66 illustrates the hydraulic system at closed throttle in manual low second gear.

MAIN CONTROL PRESSURE SYSTEM

❶ The main regulator valve is controlling line pressure and supplying the converter, cooler and lube systems.

❷ LINE BOOST pressure is effective to increase control pressure, since the 2-3 shift valve is "downshifted".

❸ Passages P-1-R, P-3-1-R and OD-3-1 are charged at the manual valve. The REV and OD-3 passages are exhausted.

T.V. SYSTEM

❹ T.V. is exhausted at closed throttle.

❺ Both backout valves are in the spring-loaded "in" position.

FORWARD CLUTCH SYSTEM

❻ The forward clutch remains applied; pressure is through the OD-3-1 passage, 3-4 shift valve, orifice control valve, 2-3 backout valve and A orifice.

GOVERNOR AND SHIFT VALVES

❼ The governor pressure output is high enough to hold the 1-2 shift valve in the upshifted (inward) position.

❽ OD-3-1 line pressure thus is available to hold the intermediate clutch applied.

❾ The 2-3 and 3-4 shift valves are forced to the downshifted (outward) positions by line pressure on the spring ends; as well as on differential areas (see Upshift Delay Pressures in the preceding section).

O.D. SERVO APPLY

❿ The 3-4 shuttle valve is held out by P-1-R pressure assisting the spring.

⓫ Pressure in the 3-4 ACCUM passage is effective through a drilled hole in the O.D. servo regulator valve; which is held **inward** and cannot regulate.

⓬ The release side of the servo is exhausted through the 2-3 shift valve and the OD-3 passage (to the manual valve).

⓭ Line pressure on the apply side of the O.D. servo piston can now apply the O.D. band.

2-1 SCHEDULING PRESSURE

⓮ The 2-1 scheduling valve is regulatng 2-1 SCHEDULING pressure from pressure in the P-1-R passage.

⓯ Regulated pressure is effective to the spring end of the 1-2 shift valve. This will assist line pressure at two differential areas to force the valve to downshift as governor pressure is reduced at lower road speed.

SUMMARY OF VALVE POSITIONS

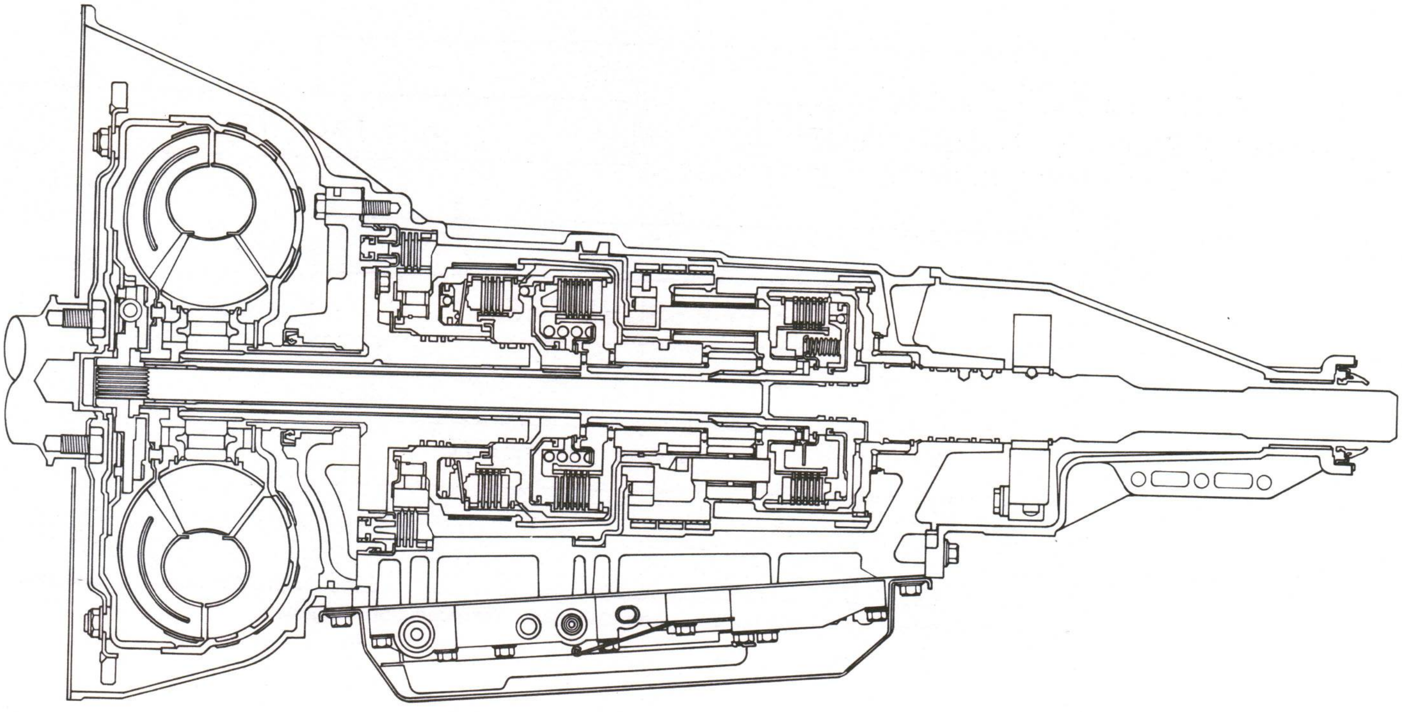
VALVE	P	R	N	OD & 3 1st	OD & 3 2nd	OD & 3 3rd	OD 4th	1 (MAN) 1st	1 (MAN) 2nd
1-2 Cap. Mod.	Always OUT Except Regulates During 1-2 Shift								
1-2 Accum.	IN	IN	IN	OUT	IN	IN	IN	OUT	IN
3-4 Shuttle	OUT	OUT	OUT	IN	IN	IN	OUT	OUT	OUT
O.D. Servo Reg.	IN	IN	IN	IN	REG.	REG.	IN	IN	IN
1-2 Shift	OUT	OUT	OUT	OUT	IN	IN	IN	OUT	IN
T.V. Limit	Normally IN Except Regulates at Heavy Throttle								
3-4 Shift	OUT	OUT	OUT	OUT	OUT	OUT	IN	OUT	OUT
3-4 Throttle Mod.	IN	IN	IN or REG	IN	IN	IN or REG	IN	IN	IN
Orifice Control	IN	IN	IN	OUT	OUT	IN	IN	OUT	OUT
2-3 Cap. Mod.	Always IN Except Regulates During 2-3 Shift								
2-3 Backout	IN At Closed Throttle, Otherwise OUT								
2-3 Shift	OUT	OUT	OUT	OUT	OUT	IN	IN	OUT	OUT
2-3 Throttle Mod.	IN	IN	IN Or Regulating					IN	IN
3-4 Backout	IN (or Regulates During 3-4) at Closed Throttle, Otherwise OUT								
2-1 Scheduling	OUT	IN	IN	IN	IN	IN	IN	OUT	REG
Low Servo Mod.	REG	OUT	IN	IN	IN	IN	IN	REG	IN
Main Regulator	Always Regulating								
Booster	Normally Contacts Main Regulator Valve Except OUT at Closed Throttle in 3rd and 4th								
Manual	Manually Positioned by Driver								
Plunger	Moves with Throttle Linkage								
Throttle	Always Regulating Except at Heavy Throttle								
Throttle Plug	Always Contacts Throttle Valve								

This chart is for reference only and shows the normal operating position for each valve. The positions are given as outward, inward, or regulating.

AUTOMATIC OVERDRIVE TRANSMISSION

SECTION 6

DIAGNOSIS



GENERAL DIAGNOSIS SEQUENCE

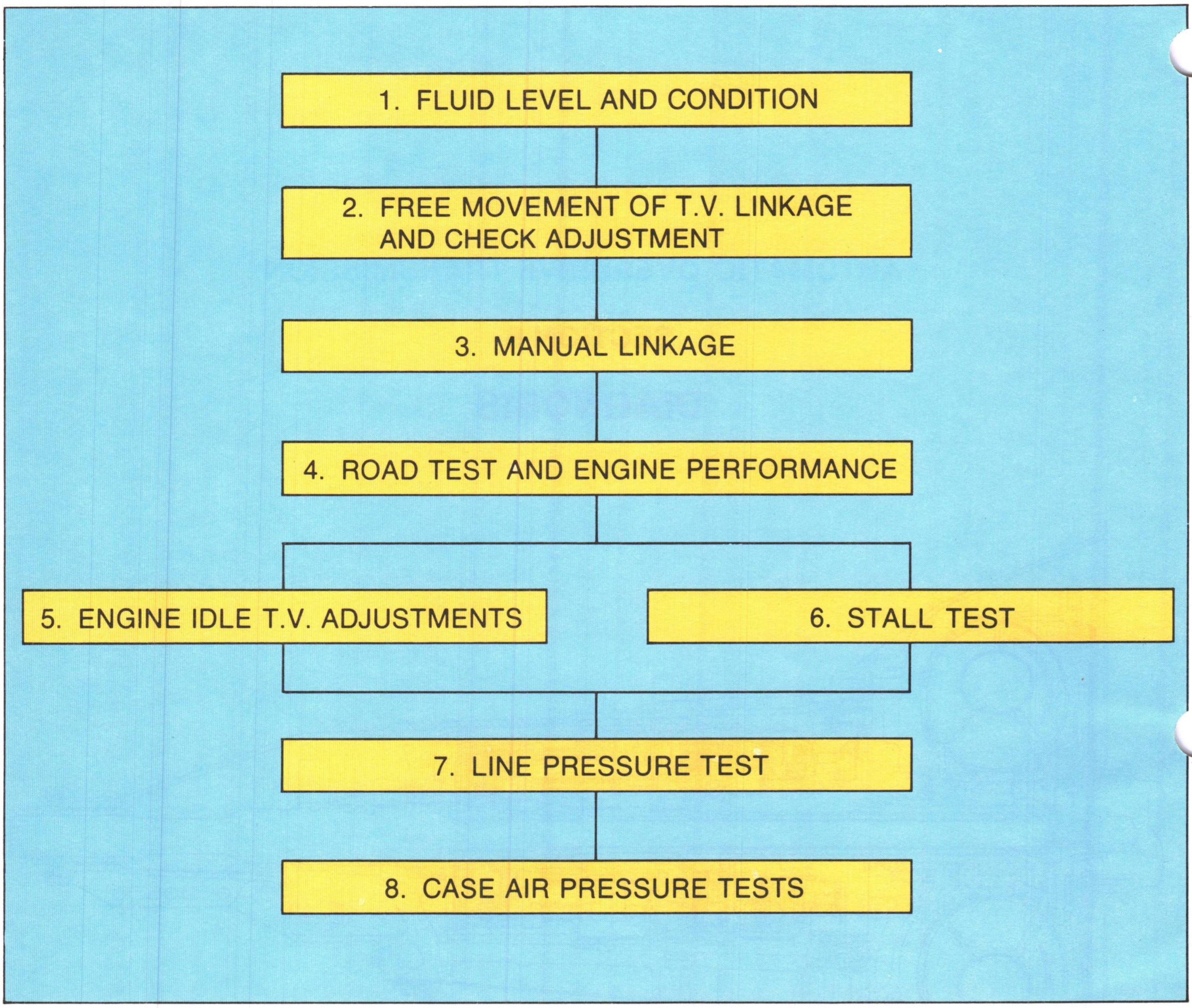

1. FLUID LEVEL AND CONDITION
2. FREE MOVEMENT OF T.V. LINKAGE AND CHECK ADJUSTMENT
3. MANUAL LINKAGE
4. ROAD TEST AND ENGINE PERFORMANCE
5. ENGINE IDLE T.V. ADJUSTMENTS
6. STALL TEST
7. LINE PRESSURE TEST
8. CASE AIR PRESSURE TESTS

Figure 67 — General Sequence for Automatic Overdrive Transmission Diagnosis

The general sequence for diagnosis of the automatic overdrive transmission (Figure 67) is similar to other Ford automatics. It is generally recommended that the first three checks; fluid, T.V. linkage and manual linkage be made before the road test. **Never drive the car unless the fluid level is correct, the manual selector is in synchronization with the detents, and the T.V. linkage moves free of all obstructions.** The sequence of tests 5 through 8 can vary, then, depending on the condition(s) encountered on the road test.

For example, conditions related to engagement or shift feel would generally lead to checking and possibly re-adjusting the T.V. linkage properly. Slipping conditions that occur in only certain gears might call for a stall test and/or line pressure test. Case air pressure tests, of course, require removing the valve body, and so should be used after the other checks have been done to isolate the problem.

IMPORTANT: T.V. ADJUSTMENT IS CRITICAL

On the road test, be alert for soft or mushy shifting o engagement. If this occurs, do **not** drive the vehicle at heavy throttle. Low T.V. pressure could cause damage. Check the T.V. and set it up properly; then give the car a full road test. **Most shifting problems will be related to T.V.**

FLUID LEVEL CHECK

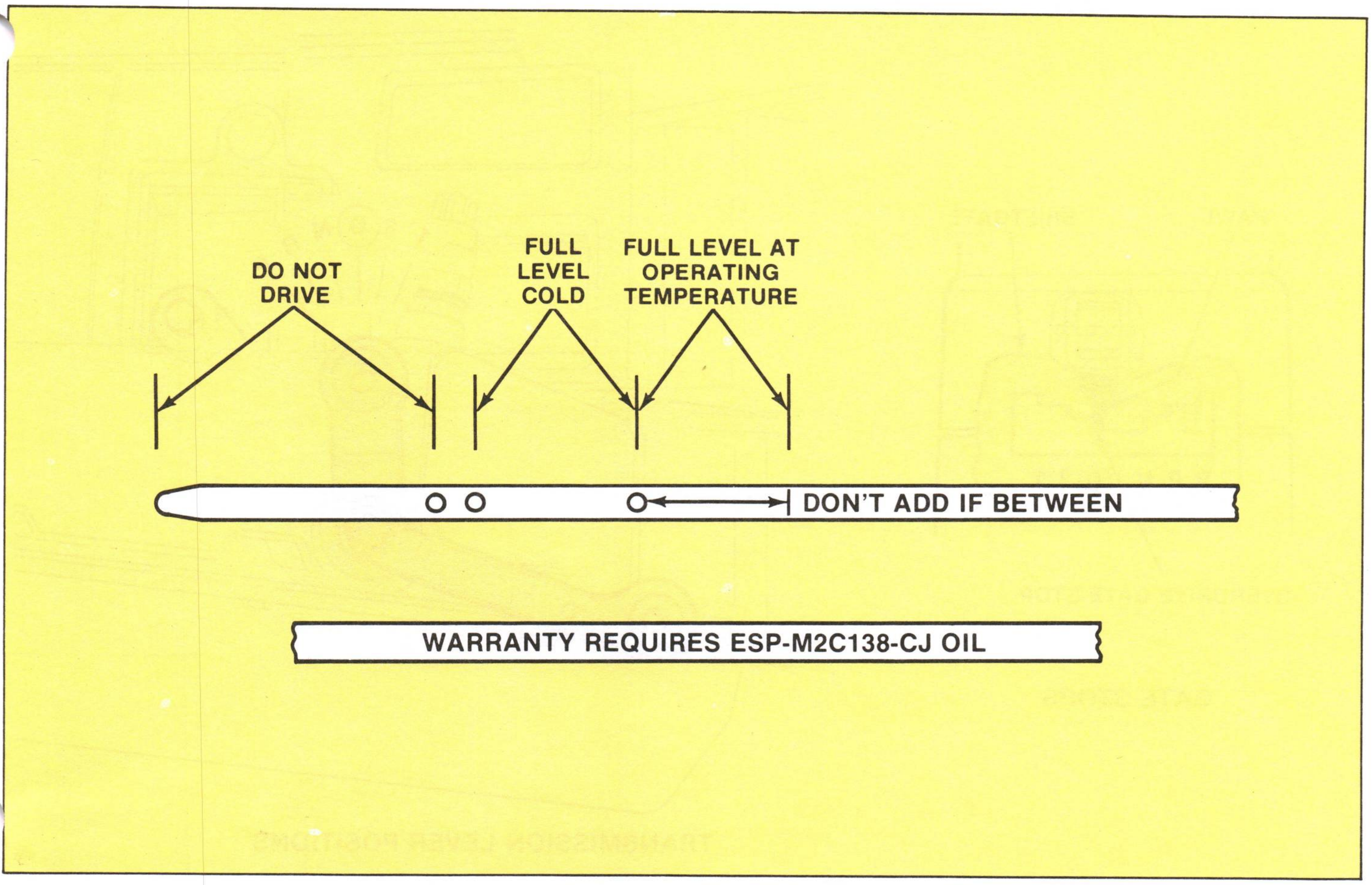

DO NOT DRIVE
FULL LEVEL COLD
FULL LEVEL AT OPERATING TEMPERATURE
DON'T ADD IF BETWEEN
WARRANTY REQUIRES ESP-M2C138-CJ OIL

Figure 68 — Fluid Dipstick Markings

PRE-ROAD TEST CHECK

The fluid level should ideally be checked with the transmission at operating temperatures. Test conditions are:

- Engine at hot curb idle.
- Shift selector in Park (after moving through all the ranges to fill clutch and servo cavities).

For road testing, a cold check can be made. The fluid level should be between the inner holes (Figure 68). If the level is at or below the lowest hole, the vehicle should **not** be driven without adding fluid.

HOT FILL

After the vehicle is driven some 20 minutes, the fluid temperature should be in the operating range of 130-180 degrees Fahrenheit (55°C-85°C).

The final fluid fill should always be between the arrows (Figure 68), at operating temperature.

IMPORTANT: DO NOT OVERFILL. THE SPACE BETWEEN THE ARROWS IS SLIGHTLY LESS THAN ONE PINT. DO NOT FILL TO THE ARROWS UNLESS THE TRANSMISSION IS HOT.

CHECK FOR LEAKS

If the fluid level checks low, be sure to leak test the transmission after the road test. Locate and repair leaks the same as on any other Ford automatic.

FLUID SPECIFICATION

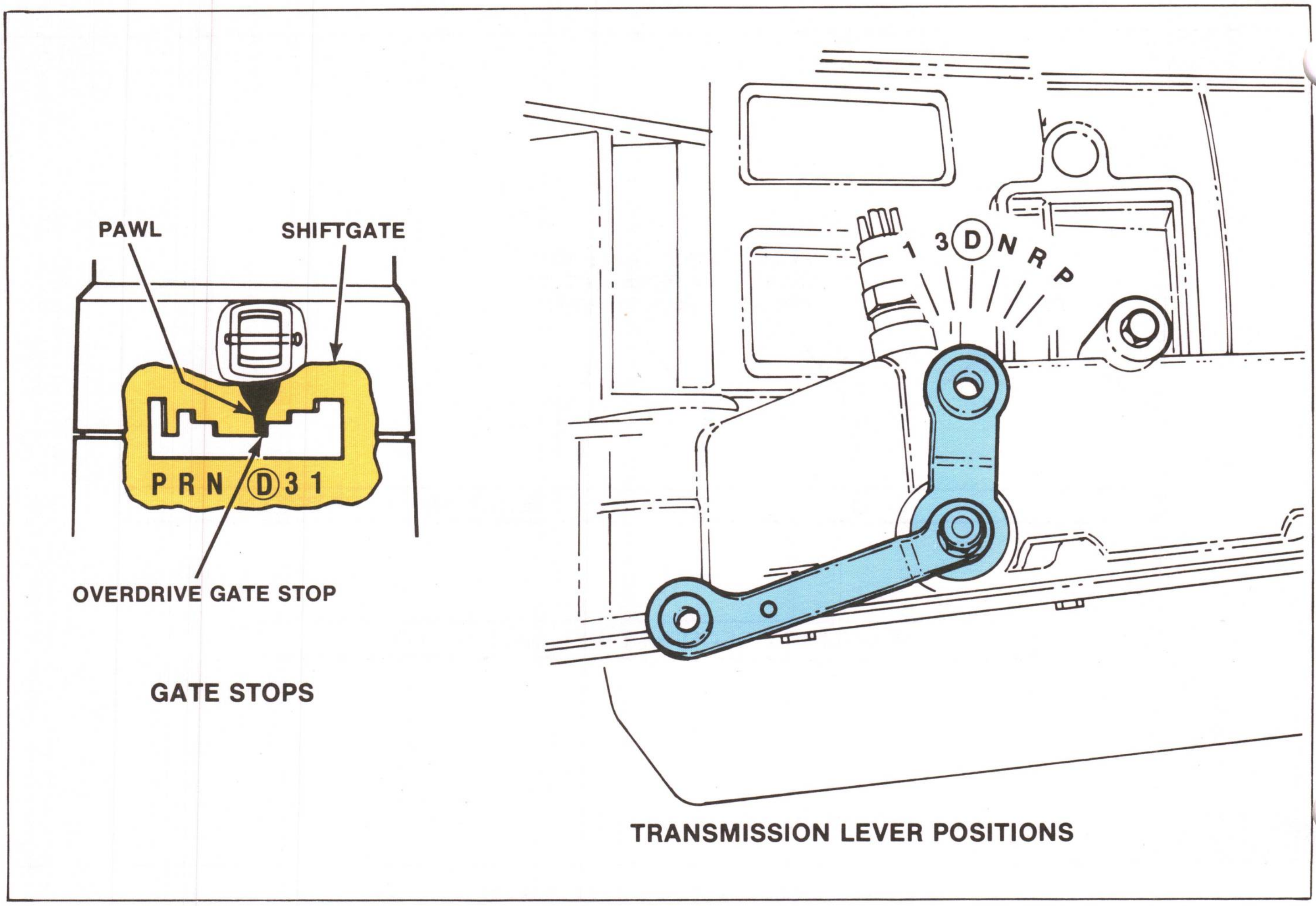
The automatic overdrive transmission uses 12 quarts of type CJ transmission fluid for a complete fill. (This is the same fluid used in late model C6 transmissions). The use of incorrect fluid, as noted on the dipstick, will void the warranty.

NEVER ADD TYPE A OR TYPE F WHERE CJ IS SPECIFIED. IN AN EMERGENCY, DEXRON II MAY BE USED TO FILL TO A SAFE DRIVING LEVEL.

FLUID CONDITION

If the fluid is burnt or discolored, or if it has band or clutch residue, the transmission should be overhauled. During overhaul, be sure to flush the torque converter and cooler. Also determine the cause of the condition and fix it so it doesn't happen again.

MANUAL LINKAGE CHECK



GATE STOPS

TRANSMISSION LEVER POSITIONS

Figure 69 — Manual Linkage Gate Stops and Lever Positions

PRE-ROAD TEST CHECK

This is a simple check to make at the write-up area or beginning the road test. (The engine can be off.)

1. Pull the shift lever toward you to "ungate" it. Move it through all the ranges.
2. Feel the detents in the transmission. Are they synchronized with the markings on the shift selector?
3. Shift to the O/D (overdrive) position detent and let the lever drop into position.
4. Check if the shift gate pawl (Figure 69) is against the O/D stop by trying to move the lever toward position 3 **without ungating it.**

If there is free movement to the O/D stop; or if the pawl is up on the 3 stop, an adjustment is required.

DO NOT DRIVE THE CAR IF THE ADJUSTMENT IS NOT CORRECT.

ADJUSTMENT

To make the adjustment:

1. Loosen the linkage adjustment screw. This screw is located in the engine compartment on the Ford, Mercury, Lincoln and Mark VI models. On the Thunderbird and XR-7 models the linkage adjustment screw is reached from beneath the vehicle. Refer to shop manual of the particular vehicle for linkage illustrations.
2. Move the shift selector **firmly against** the O/D gate stop. (Hang an 8-pound weight on the selector lever to hold it in place.)
3. Locate the O/D detent in the transmission. It will be the **third** from the front as illustrated in Figure 69.
4. Tighten the linkage adjustment screw. The O/D detent and the gate stop should now be synchronized.
5. Recheck the adjustment before driving the vehicle.

ROAD TEST

RANGE	CHECK FOR	CONDITION (OK OR NOT OK)
1	Engagement	
	No 1-2 Upshift	
	Engine Braking in 1st and 2nd Gear	
	Slipping	
3	Engagement and Shift Feel	
	1-2-3 Automatic Upshifts at Specified Speeds	
	Fourth Gear Lockout	
	Torque Demand 3-2 Only	
	W.O.T. Kickdown to Second or First	
	Smooth Coastdown	
	Slipping	
Ⓓ	Engagement and Shift Feel	
	1-2-3-4 Automatic Upshifts at Specified Speeds	
	Torque Demand to Third Gear from O.D.	
	W.O.T. Kickdown to Second or First	
	No Fourth Gear at W.O.T.	
	Smooth Coastdown	
	Slipping	
R	Engagement	
	Back-Up Without Slip	
	Slipping	

Figure 70 — Road Test Check Chart

Figure 70 shows the items that should be checked on a properly conducted road test. In addition, you should refer to the Performance Specifications for proper shift points. Also, use the Band and Clutch Application Chart on page 26 to help analyze the results.

Some tips on diagnosing problems with specific components are:

Intermediate Clutch or One-Way Clutch — transmission shifts 1-3 or slips in second gear.

Reverse Clutch — slip or no engagement in R. (Also can be caused by the low-reverse band or servo.)

Forward Clutch — no engagement in forward ranges, or slip in forward.

Overdrive Band or Servo — no fourth gear, slip in fourth gear, or no engine braking in second gear in range 1.

Direct Clutch — Slip in third or fourth, or no upshift beyond second.

Low-Reverse Band or Servo — no reverse or slip in reverse. Possibly no engine braking in manual low first gear, which would isolate the problem to the band rather than reverse clutch.

ACCUMULATORS

Leaking seals on the accumulator pistons can cause their respective clutches to slip. If the 2-3 accumulator seals leak, the symptoms could resemble a direct clutch or forward clutch problem. A leaking 3-4 accumulator will cause a soft or harsh 3-4 upshift (depending on where the leak is).

T.V. PRESSURE LOW

Another reminder: if the shifts seem soft or mushy, do not make any heavy throttle tests. Check and adjust the T.V. linkage before making a complete road test.

SHIFT TROUBLE DIAGNOSIS

SYMPTOMS	CAUSE	CORRECTION
1. Early and/or soft upshift; 2. Slip-bump feel on light throttle 3-4 or 4-3; 3. No kickdown or wrong kickdown speeds	T.V. control linkage is set too short	1. Perform "Carburetor Linkage Adjustment" 2. If adjusting screw has insufficient travel, perform "Transmission Linkage Adjustment"
1. Harsh idle engagement with engine hot (at curb idle) 2. Shift clunk in "Backout" shifts 3. Harsh 4-3 coasting shift	T.V. control linkage is set too long	1. Perform "Carburetor Linkage Adjustment" 2. If adjusting screw has insufficient travel, or condition is not corrected, perform "Transmission Linkage Adjustment"
1. Very late and harsh upshifts; especially at moderate acceleration 2. Harsh idle engagement	Interference prevents T.V. rod return	Correct interference
	Binding grommets prevent T.V. return	1. Check for bends or twists that cause misalignment 2. Replace grommets if damaged 3. Adjust T.V. linkage
	T.V. rod disconnected (T.V. is at W.O.T.)	1. Check for grommet damage 2. Connect rod 3. Adjust T.V. linkage
	Loose clamping bolt on T.V. rod trunnion (T.V. is at W.O.T.)	Adjust T.V. linkage
	Linkage lever return spring is broken or disconnected (T.V. is at W.O.T.)	Repair, or replace spring

Figure 71 — Diagnosis of Shift Conditions Related to T.V. Linkage

Adjustments of the T.V. system are required generally for the conditions listed in Figure 71. The adjustments listed in the **correction** column are covered in detail on the following pages.

THE LONG AND SHORT OF IT . . .

When diagnosis seems to be a too short linkage condition, there should be an initial gap between the throttle lever and the adjusting screw; or a gap should show when the screw is backed out one turn (Figure 72). If this is not so, the diagnosis is incorrect. Similarly, with the linkage set too long, it should take **five** turns of the screw to see a gap. If it doesn't, the diagnosis is incorrect. The screw should be reset to mid-range and adjustment made at the transmission.

CARBURETOR LINKAGE AND IDLE SPEED ADJUSTMENT

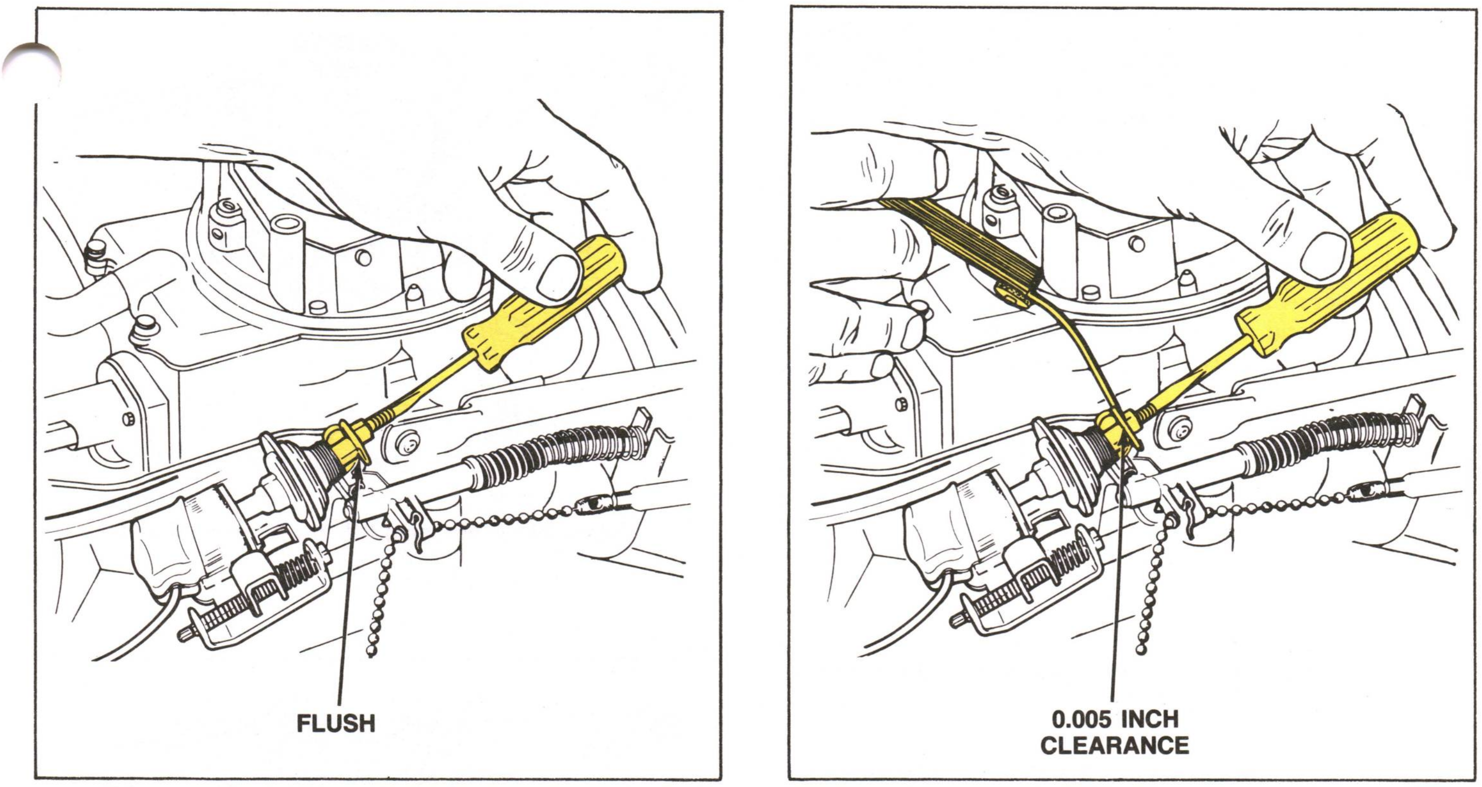


Figure 72 — T.V. Linkage Adjustment at Carburetor

CARBURETOR LINKAGE ADJUSTMENT

IMPORTANT: THE ENGINE MUST BE SET TO THE HOT CURB IDLE SPEED SPECIFIED ON THE DECAL BEFORE ADJUSTING THE T.V. CARBURETOR LINKAGE.

1. Place shift lever in neutral and set park brake (Engine Off).
2. Remove the air cleaner and release the fast idle cam. **The throttle lever must be at the idle stop** (TSP-off).
3. Turn the linkage lever adjustment screw (Figure 72 left) out until its tip is flush with the lever face.
4. Turn the screw in until there is 0.005 inch clearance between the screw tip and the throttle lever (Figure 72 right). **IMPORTANT:** To eliminate effect of friction, push linkage lever forward (tending to close gap) and release before checking clearance. Do not apply any load on levers with tool or hands while checking gap.
5. Remove the feeler gauge and turn the screw in (clockwise) exactly **three full turns.**

NOTE: If the screw travel is limited, a minimum of one full turn is acceptable. If there is not enough travel for one full turn, perform the "Transmission Linkage Adjustment" (next page).

IDLE SPEED ADJUSTMENT

Anytime that the curb idle speed is changed by 50 RPM or more, the adjustment of the linkage lever screw **must** be changed as follows for correct T.V. input:

IDLE SPEED CHANGE	ADJUSTMENT
50-100 RPM Increase	1-1/2 Turns Out (CCW)
50-100 RPM Decrease	1-1/2 Turns In (CW)
100-150 RPM Increase	2-1/2 Turns Out (CCW)
100-150 RPM Decrease	2-1/2 Turns In (CW)

If the idle speed adjustment is reset to within 50 RPM of the original setting, the T.V. linkage lever screw should not require re-setting.

NOTE: Always verify that the linkage lever screw and the throttle lever are in contact, in the idle stop position, and in neutral after **any** idle adjustment. If they are not, perform the linkage adjustment.

TRANSMISSION LINKAGE ADJUSTMENT

The transmission linkage adjustment consists of adjusting the length of the T.V. control rod assembly at the transmission. This should be done anytime the adjustment screw at the carburetor linkage lever (Figure 72) will not adjust as specified. Also, it should be done anytime a new T.V. rod is installed.

To make the adjustment:

1. Set the screw at the T.V. Linkage lever (Figure 72) at its mid-point and be sure the throttle is against the idle stop. Place shift lever in neutral and firmly set parking brake.
2. Loosen the bolt (Figure 73) on the T.V. control rod sliding trunnion block. (13 mm hex wrench).

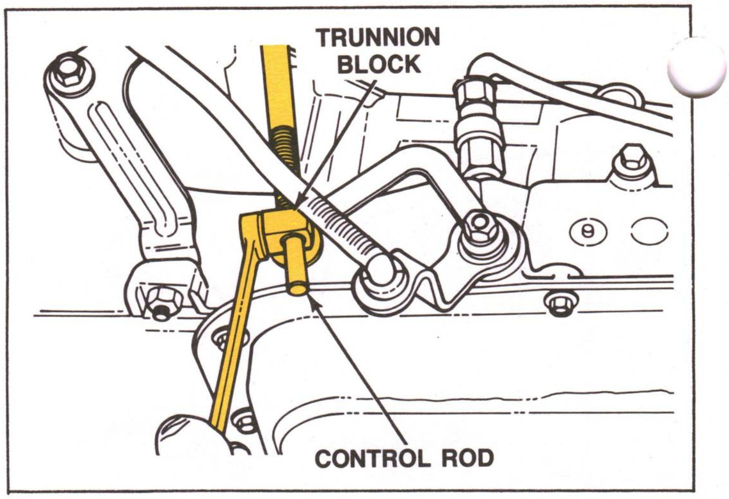


Figure 73 — Loosening T.V. Rod Trunnion Block

3. Clean up the trunnion and rod so that the trunnion slides freely on the rod.
4. Push up on the lower end of the T.V. rod (Figure 74) to assure that the carburetor linkage lever is held firmly against the throttle lever.

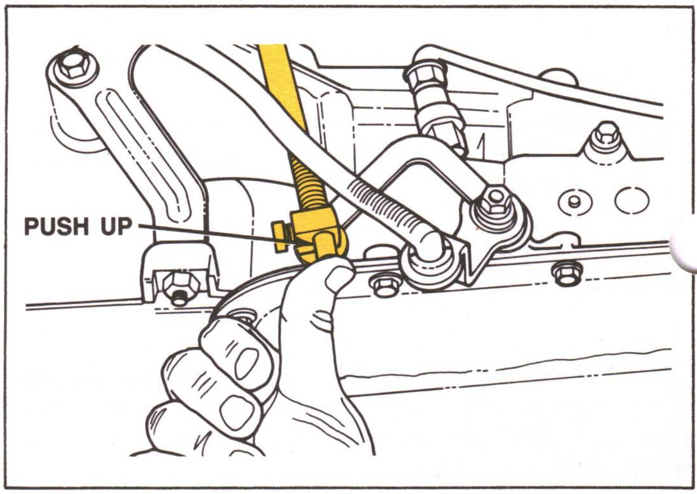


Figure 74 — Positioning Control Rod

5. Release the rod and be sure it stays in position. If it doesn't, return spring at carburetor is disconnected or damaged.
6. Push the transmission T.V. lever up against its internal stop with a firm force and tighten bolt on trunnion block. Do not relax force on lever until bolt is tightened.
7. Again, verify that the throttle lever is at the idle stop.

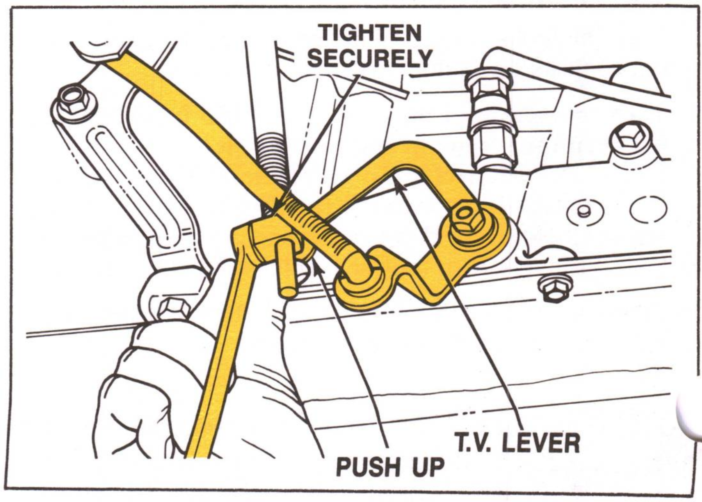


Figure 75 — Holding Lever and Tightening Trunnion

T.V. PRESSURE ADJUSTMENT

Because of the critical relationship between the carburetor throttle setting and T.V. pressure, the linkage adjustment can be checked or adjusted with a pressure gauge.

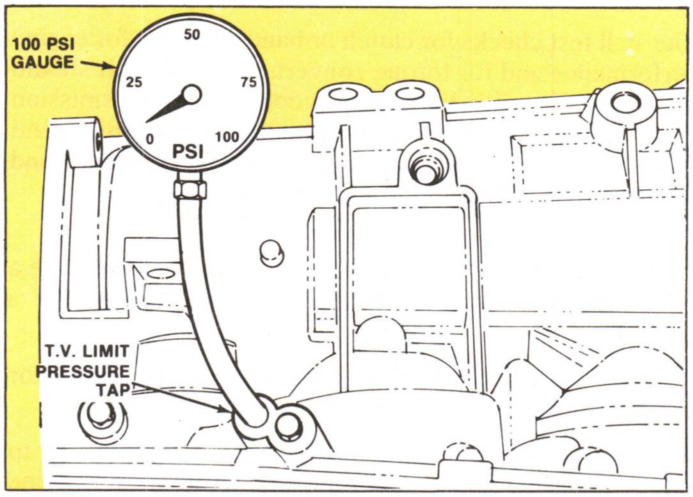


Figure 76 — T.V. Limit Pressure Gauge

Here is the procedure:

1. Connect a 100 psi pressure gauge to the T.V. limit pressure tap on the right side of the case (Figure 76). Use a gauge hose long enough that you can see it from under the hood.

2. Verify that the throttle lever is at the idle stop. Idle the engine in neutral and set park brake.

3. Place a 1/16 inch (1.6 mm) drill or gauge between the linkage lever adjustment screw and throttle lever (Figure 77). **Check that T.V. pressure is 5 psi or lower.**

   If the T.V. pressure is above 5 psi, the linkage is set too long. Back the screw out as necessary to reduce pressure.

4. Replace the 1/16 inch gauge with a 5/16 inch (8 mm) gauge. **With the engine idling in neutral, T.V. pressure must be at least 22 psi.**

   If the T.V. pressure is now lower than 22 psi, the control linkage is set too short. Turn the screw in as required to bring the pressure up to 22 psi.

NOTE: If the correct T.V. pressures cannot be set at the linkage lever adjustment screw, it may be necessary to adjust the control rod length at the transmission. Follow the procedure on the preceding page.

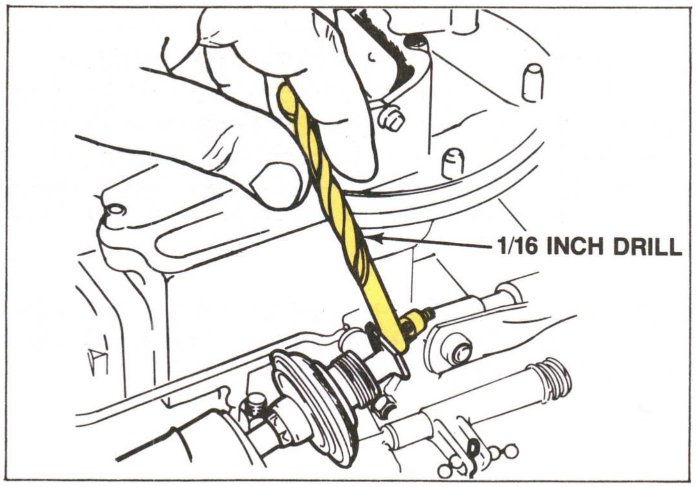


Figure 77 — Positioning Linkage Lever for 5 PSI Check

STALL TEST

The stall test checks for clutch or band slippage, for engine performance and for torque converter operation. It should be done only with the engine coolant and transmission fluid at proper levels and at operating temperature, and with the T.V. linkage set properly. **Apply the service and parking brakes firmly for each stall test.**

1. Look up the specified stall RPM for the vehicle. Use a grease pencil to mark the RPM on the dial of a tachometer.
2. Connect the tachometer to the engine and position it for easy reading from the driver seat (Figure 78).
3. In each of the following ranges, press the accelerator to the floor and hold it just long enough to let the engine get to full RPM.

RANGE	HIGH, LOW OR OK
OD	
3	
1	
R	

IMPORTANT: IF THE NEEDLE GOES PAST THE MARK, SOMETHING IS SLIPPING. RELEASE THE ACCELERATOR IMMEDIATELY.

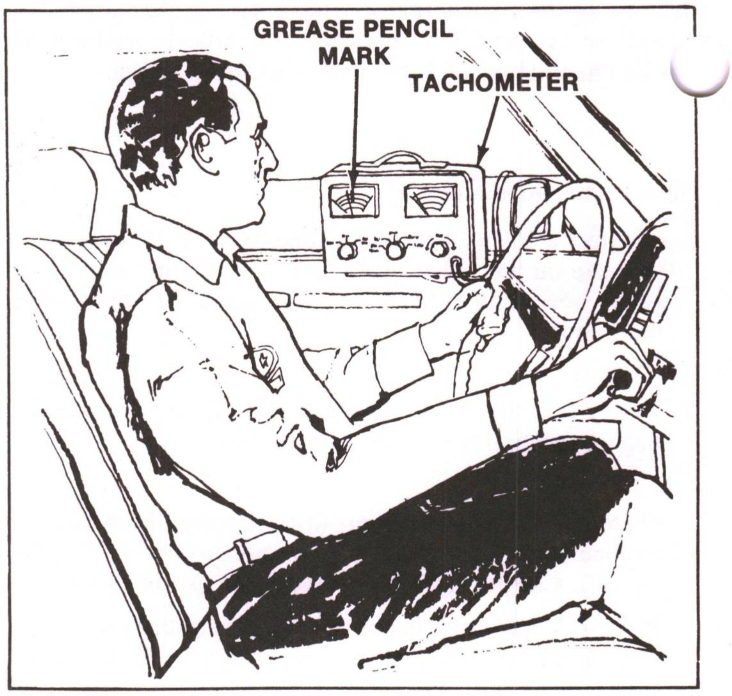


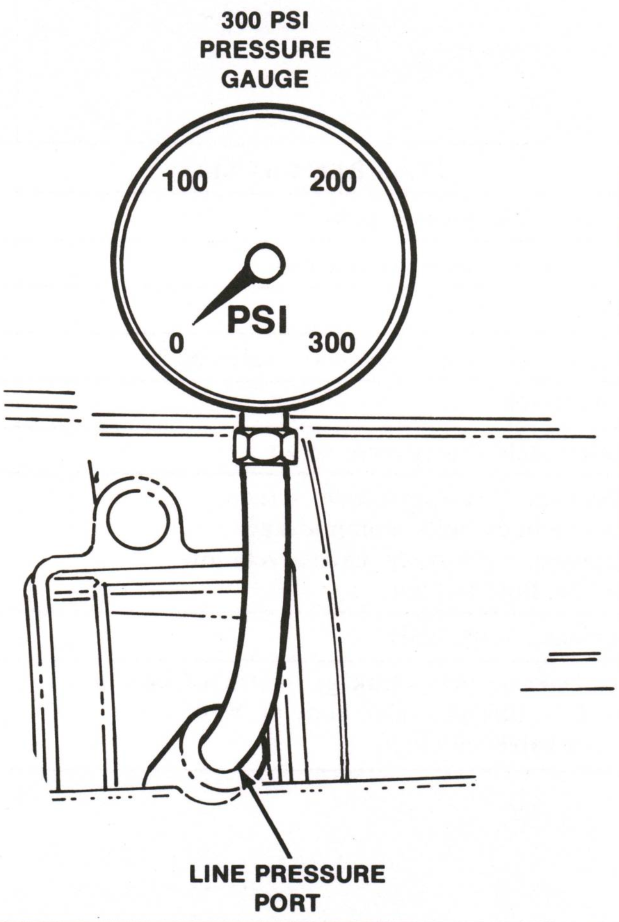
Figure 78 — Stall Testing

4. Record the results in each range (high, low or OK).
5. Run the engine at fast idle, in neutral, between each test to cool the fluid.
6. Refer to Figure 79 for further checks or corrective action to take.

SELECTOR POSITIONS	STALL SPEED(S) HIGH (SLIP)	STALL SPEEDS LOW
Ⓓ and 3	Low (Planetary) One-Way Clutch	1. Check Engine for Tune-Up. If OK . . . 2. Remove torque converter and Bench Test for Stator One-Way Clutch Slip.
Ⓓ , 3 and 1	Forward Clutch	
All Driving Ranges	1. Check T.V. Adjustment 2. Perform Control Pressure Test	
R Only	Reverse Clutch or Low-Reverse Band or Servo	

Figure 79 — Stall Test Results Chart

CONTROL PRESSURE TEST



LINE PRESSURE (PSI)

IDLE (CLOSED THROTTLE)		
Position	**Specified**	**Actual**
P		
R		
N		
D		
3		
1		

WIDE-OPEN THROTTLE (FULL T.V.)		
Position	**Specified**	**Actual**
D		
3		
1		
R		

Figure 80 — Control (Line) Pressure Test

Line pressure on the automatic overdrive is tested in the idle position (zero T.V.) and wide-open-throttle position (full T.V.). It is suggested that the test specifications and results be recorded on paper on a chart similar to the one in Figure 80. (In each of the two modes, the Reverse specifications will be higher than the others.

TEST PROCEDURE

1. Connect a 300 psi gauge to the line pressure port on the case **left** side; just above the control levers.

2. **Run the engine until it is hot.** Idle pressure **must** be read with the throttle **off** the fast idle cam.

3. Be sure the T.V. linkage is properly adjusted.

4. Apply the service and parking brakes firmly and shift through all the ranges. Record the line pressure and compare it with specifications.

NOTE: W.O.T. readings are to be made at full stall. However, be sure to run the engine at fast idle in neutral for cooling between tests.

5. Refer to the Control Pressure Test Results Chart on the next page (Figure 81) for possible conditions disclosed by out-of-specification pressure readings.

CONTROL PRESSURE TEST RESULTS

CONTROL PRESSURE CONDITION	POSSIBLE CAUSE(S)
Low in P	Valve body, low-reverse servo
Low in R	Reverse clutch, low-reverse servo
Low in N	Valve body
Low in Ⓓ	Forward clutch, overdrive servo, valve body
Low in 3	Forward clutch
Low in 1	Forward clutch, low-reverse servo
Low at idle in all ranges	Low fluid level, restricted inlet screen, loose valve body bolts, pump leakage, case leakage, valve body, excessively low engine idle, fluid too hot.
High at idle in all ranges	T.V. linkage, valve body
Okay at idle but low at W.O.T.	Internal leakage, pump leakage, restricted inlet screen, T.V. linkage, valve body (T.V. or T.V. limit valve sticking)

Figure 81 — Control Pressure Test Results Chart

After making the control pressure tests, analyze the results to relate to the conditions in Figure 81.

Keep in mind that clutch and servo leakage may or may not show up on the control pressure test. This is because (1) the pump has a high output volume and the leak may not be severe enough to cause a pressure drop; and (2) orifices between the pump and pressure chamber may maintain pressure at the source, even with a leak downstream. Pressure loss caused by a less-than-major leak is more likely to show up at idle than at W.O.T. where the pump is delivering full volume.

Conversely, if you are manipulating the T.V. linkage to simulate W.O.T., but actually testing at idle, the leak is more likely to cause a pressure loss in the W.O.T. position.

To further isolate leakage in a clutch or servo circuit, it is necessary to remove the oil pan and valve body, and to perform case air pressure tests (next page).

AIR PRESSURE TESTS

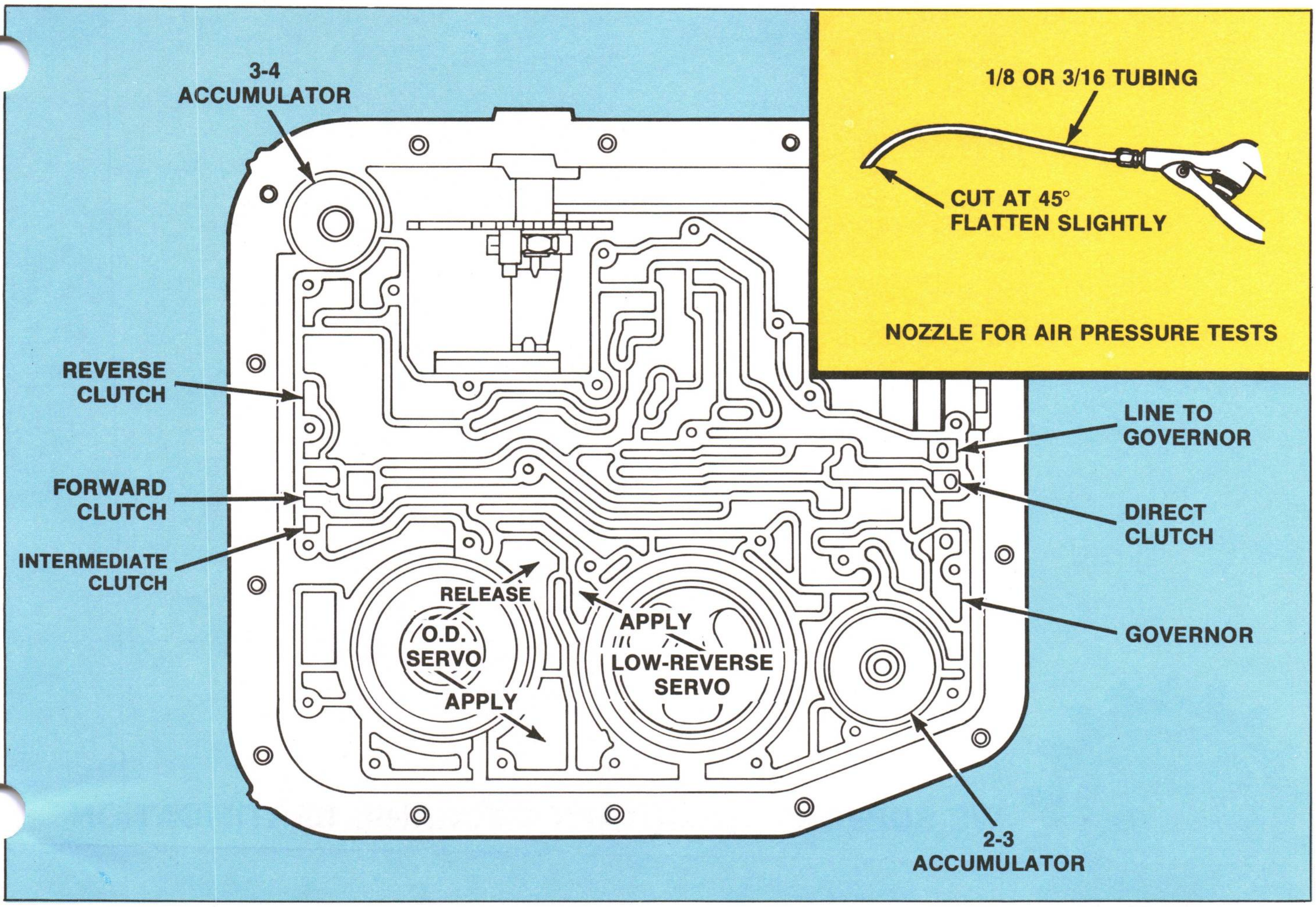


Figure 82 — Automatic Overdrive Transmission Case Air Test Pressure Passages

The clutch and servo circuits through the case, pump assembly and output shaft can be air tested through the passages identified in Figure 82. A nozzle should be used similar to that shown in the inset view. A rubber tip is helpful when the nozzle is inserted into a fluid supply hole. Where there is not a tight fitting hole in the passage, stuff rags around the nozzle.

Air pressure should be regulated to about 25 psi. The compressed air should be filtered and dry to avoid contaminating the fluid.

CLUTCHES

The clutches should apply with a dull thud when compressed air is blown into their pressure ports. A hissing sound and the absence of application noise indicates a leak.

SERVOS

The low-reverse servo application should be heard as the piston bottoms with air applied. When the air is removed, you should be able to feel the piston move back against the cover.

For the overdrive servo test, first pressurize the apply side. Hold the pressure and pressurize the release side. You should hear the piston stroke to apply the band and also hear it bottom in the cover when release pressure is applied.

Hissing noise indicates a leak.

GOVERNOR

Air blown into the LINE TO GOVERNOR passage should cause the governor to whistle. If there is no noise, the governor may be stuck.

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